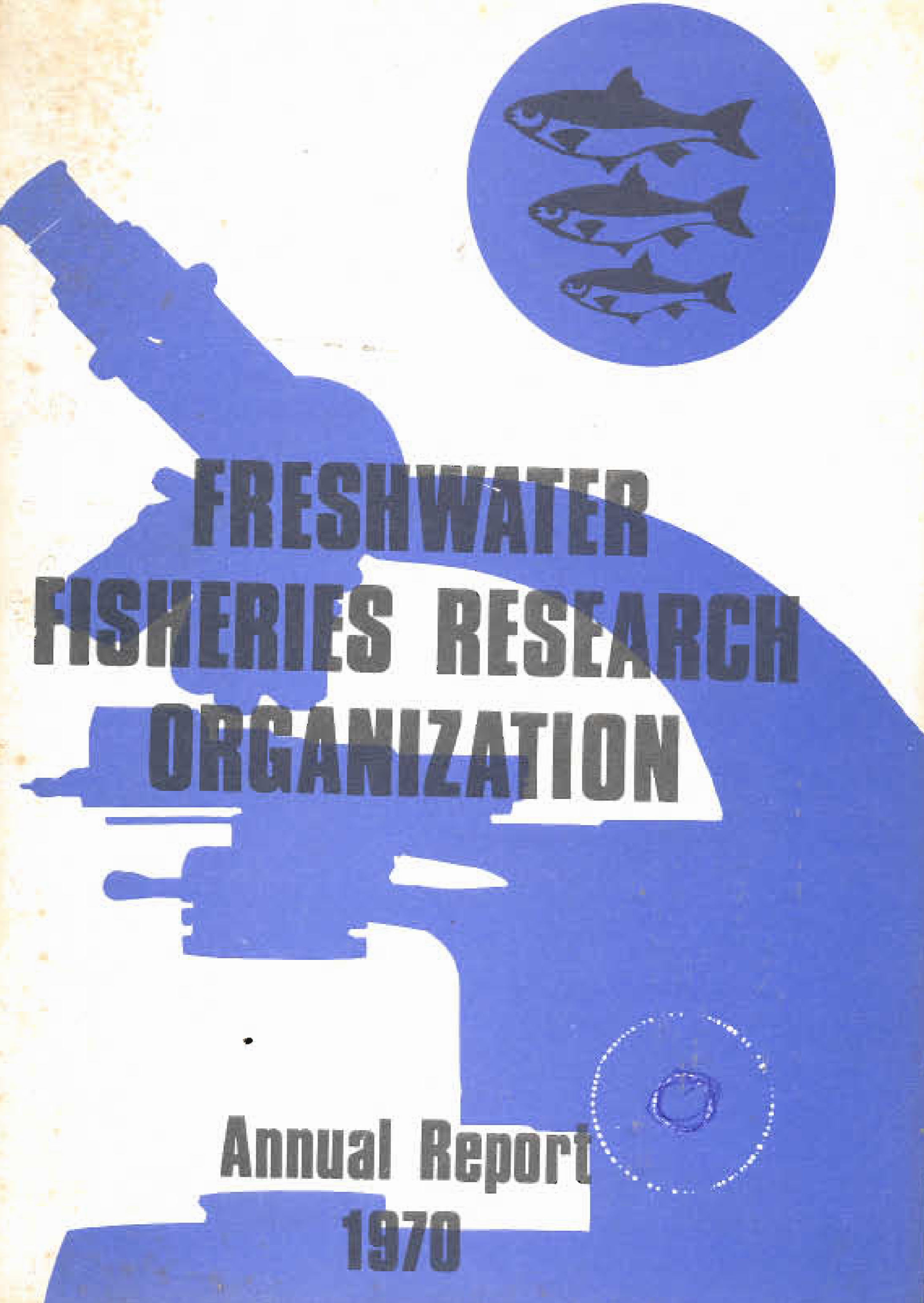
FRESHWATER FISHERIES RESEARCH ORGANIZATION



Annual Report 1970

EAST AFRICAN COMMUNITY

EAST AFRICAN FRESHWATER FISHERIES RESEARCH ORGANIZATION

ANNUAL REPORT 1970

Six Shillings — 1971

E.A.F.F.R.O.
P. O. Box 343,
JINJA, UGANDA.

CONTENTS

EAST AFRICAN FRESHWATER FISHERIES RESEARCH ORGANISATION

ANNUAL REPORT 1970

STAFF

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R.M. Chilvers, B.Sc.
J.M. Gee, Ph.D.
Vacant (1)

Research Officers (Trainee):
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D.L. Ocenodongo, B.Sc.
T. Twongo, B.Sc.

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Miss. F.A. Namataka

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Artisan (Fisheries) :
S. Ongeso

Senior Coxswain :
W. Odongo

Coxwains :
E. Odwori
A. Mukholo

UNITED NATIONS DEVELOPMENT PROGRAMME
(SPECIAL FUND PROJECT)

(F.A.O. Experts)	**(E.A.F.F.R.O. Counterparts)**
Project Manager :	**Co-Manager :**
P.B.N. Jackson, M.Sc.	J. Okedi, Ph.D.
Limnologist :	G.E.B. Kitaka, M.Sc.
Biologist (Stock Assessment :	W. Kudhongania, M.Sc.
A.J. Cordone, M.Sc.	
Ecomist (Costs) :	C. Nsherenguzi, M.A.
P.S. Whiting	
Economist (Marketing) :	V. Babikanyisa, B.A. (Econ.)
E. Nyholm	B. Emeru
Masterfisherman :	
Captain G. Illugason	
Associate Biologist :	
Miss. Eva Bergstrand, B.Sc.	
Administrative Assistant :	
P. Rodriques	

STAFF

Consequent upon the creation of additional posts of Research Officer Trainee, EAFFRO was able to recruit two qualified candidates to fill these posts. The first of these, Mr. David L. Ocenodongo arrived in October on being transferred from the East African Agricultural and Forestry Research Organization. We are therefore grateful to the Director of E.A.A.-F.R.O. for enabling this transfer. The second Offieer, Mr. Timothy Twongo was recruited in November.

Mr. C.O. Akwabi was recruited to fill the vacant post of Laboratory Technician in July. Mr. M. Warukira, Senior Clerical Officer was transferred from Muguga to EAFFRO in March. For the first time, EAFFRO was able to obtain the services of a Telephone Operator, by the arrival of Miss. Martha Ariebe in August. Miss. F.A. Namataka, Pool Stenographer was transferred from the Community Headquarters in Arusha to EAFFRO in September. Her arrival was necessitated by the transfer of Miss. J. Najjemba who got married and was posted to join her husband in Kampala. Our congratulations to Miss. Najjemba and good wishes for her married life. Mr. Elijah Mangoli, Supplies Officer, was posted to EAFFRO in November to relieve the Supplies Officer, Mr. I.A. Mayawa who proceeded on leave.

EAFFRO lost the services of Mr. C.K. Nsherenguzi, Counterpart Economist, when this offieer resigned to take up another post in Dar-es-Salaam. Similarly, EAFFRO lost the serviees of Laboratory Technician, Mr. C.O. Akwabi, following his resignation in October. EAFFRO is, however, grateful to these Officers for the services they rendered.

Several of EAFFRO's Research Scientists proceeded on terminal leave. Dr. J.M. Gee proceeded on terminal leave in March and Mr. M.J. Mann, Senior Research Officer took his leave in July following completion of his contract. Mr. R.M. Chilvers, similarly proceeded on terminal leave in September. EAFFRO also lost the services of Mr. P.D. Mesvania, Foreman Artisan who retired after more than ten years in the Organization. To the above Officers EAFFRO owes many thanks for their devoted service.

Amongst the FAO/UNDP staff, Miss. Eva Bergstrand, Associate Biologist, proeeeded on terminal leave after completion of her contract in June. Likewise, Mr. E. Nyholm, Project Economist proceeded on leave after completion of his contract in December.

EAFFRO's two Trainee Biologists, namely Mr. G. Ssentongo and Mr. P. Basasibwaki continued training in the University of British Columbia in Canada. They were reported to be making satisfactory progress and should return to EAFFRO towards the end of the next year. EAFFRO's Counterpart Economist, Mr. V. Babikanyisa proceeded to the University of Washington in September to follow up a course in specialised fisheries economics leading to a Master of Arts degree. EAFFRO is grateful both to the Canadian Government and to Professor Peter Larkin of the University of British Columbia for his personal guidance and assistance rendered to EAFFRO biologists. Grateful thanks are similarly best owed on the F.A.O. and U.N.D.P. for enabling Mr. Babikanyisa to follow up his studies in the University of Washington.

VEHICLES AND LAUNCHES

In general, repair and maintenance work has been normal throughout the year although some difficulties were experienced in repairing some of the vehicles and other equipment.

The old Bedford truck UED 90 developed trouble in the steering system and the king pins of all the four wheels were worn out. A new set of king pins were fitted and the shock absorbers were replaced.

A survey on the Land-Rover USO 264 showed some mechanical short comings. Brake linings, wheel and master cylinders, rear bearings, exhaust pipe and the crown wheel were replaced. The engine was given top over-haul resulting in the replacement of four exhaust-valves and a set of gaskets.

The two new Land-Rovers UQT 282 and UQT 283 continued to render satisfactory service. However, minor repairs were conducted on shock absorbers, gear box and shivel pins. Land-Rover UQT 283 was involved in a slight accident in December while travelling in Jinja. This vehicle was completely repaired in EAFFRO workshop. A Peugeot 504 was purchased as a staff car and delivery was made in July.

The Toyota crown Estate UN 39 and the Land-Rover UN 40 both have given unsatisfactory service involving frequent high maintenance costs and this is due to the fact that the two vehicles are old and spares are often out of production, particularly for the Toyota. The three Volkswagens UZT 60, TDT 774 and UZT 14 continued to render good service and their maintenance was reasonable. The following table gives Miles/Kilometers run by each vehicle during the year.

EAFFRO Vehicles :			**Miles/Km. Run**	**Total Miles/Km.**
Bedford	UED	90	1946 miles	49,509 miles
Land-Rover	USO	264	6381 miles	51,771 miles
,, ,,	UQT	282	30255 Km.	30,405 Km.
,,	UGT	283	26310 Km.	29,355 Km.
Peugeot	UQX	482	12374 Km.	12,374 Km.

UNDP Vehicles :			**Miles/Km. Run**	**Total Miles/Km.**
Toyota Crown	UN	39	23737 Km.	91,792 Km.
Land-Rover	UN	40	3952 Miles	36,675 Miles
V/Wagen	UZT	60	12544 ,,	38,762 ,,
V/Wagen	UZT	14	8100 ,,	26,303 ,,
V/Wagen	TDT	774	2600 Miles	10,669 ,,

The Research vessel "IBIS" has been in continuous operation round Lake Victoria. Its main engine has undergone top over-haul, and the two Onan generators as well as the water pump on the 12 Kw generator were replaced. Launch No. 1 has not given any trouble and was used to collect scientific data in the north eastern shores arond Lufu and Buvuma islands. Repairs carried out on this boat included overhauling of both engines, replacement of the planks of wood on the star-board side and renewing of the tarpaulin. Launch No. 2 ran smoothly throughout the year. The dinghies were maintained properly apart from the powered dinghy whose engine experienced serious mechanical trouble in its defected starter magneto. However, due to its age, spares for this type of engine are no longer available in the market and we will be compelled to write off this enginc.

STOCK EVALUATION AND ASSESSMENT

ALMO. J. CORDONE

AND

BILL. W. KUDHONGANIA

During this period, 10 cruises were conducted with the "IBIS" for the continuance of the bottom trawl exploratory survey and initiation of the midwater trawl programme. The total catches and the relative species abundance obtained during these operations are summarized, by country, in Table 1. Other relevant parameters are shown in Table 11. These data exclude those made during miscellaneous short trips for demonstration, gear testing etc.

BOTTOM TRAWL SURVEY

Initially the bottom trawl survey was assumed to be completed in May 1970. The draft of a report describing the methods and summarizing certain general results was submitted to FAO in Rome in mid-1970. It was returned for revision and a final draft prepared and resubmitted in October 1970. It was accepted by Rome, although unresolved is the question of how to handle the large appendix containing a listing of the unadjusted results of each haul. The report minus the appendix will appear in the first issue of *The African Journal of Tropical Hydrobiology and Fisheries*.

Under preparation are a number of other reports describing the results of the survey; e.g., diel movements of fish as shown by 24-hour trawling, the influence of codend mesh-size on catch, and basic catch and life history data by lake area and country.

As mentioned previously, it was believed necessary to remedy the paucity of samples using small-mesh codends by re-initiating the field phase of the bottom trawl survey. Since November 1970, an un-numbered cruise and cruises 21 and 22 have been completed along with many samples taken during short one or two-day trips to waters close to Jinja. Cruise 23, the final trip, should be finished in early March. The data from these cruises will be incorporated into the reports mentioned above, as well as in the University of British Columbia computer programme. They will provide us with more realistic estimates of standing stock of the *Haplochromis* complex.

Results of the three most recent cruises using small-mesh codends show that the mean hourly catch rates are in the neighbourhood of 500 kilograms which are at least double the means for drags made with codends of larger-mesh size. The difference is almost entirely in the catch of *Haplochromis*. Just recently the Masterfisherman constructed a new bottom trawl with small meshes ahead of the codend. Resulsts indicate that even larger catches of *Haplochromis* can be anticipated, and that existing catehes will yield minimal standing stock estimates.

MIDWATER TRAWL SURVEY

The initial gear trials with midwater trawls began in June 1970. This was followed by three major cruises which also included further gear development. The results were disappointing and confusing and no major midwater trawl cruises have been undertaken since cruise 20 which was completed in mid-August 1970. The result of the three cruises are summarized in Table I and II. It was apparent that very low catches were made despite the large size of the trawls. Catches tend not only to be low but also highly variable. We might accept this as reflecting the density of fish in the pelagic zone except for the fact that very dense traces appear on the echosounder.

The problem was discussed at a meeting in September. It was decided that the midwater trawl survey should be postponed until the agents responsible for the traces were identified. We then embarked on a multi-gear sampling programme which involved a series of short trips to our study area; i.e. the bays and channels north of Buvuma Island. During the four months from September to December, we tested a variety of gear and techniques and came to the following conclusions:

1. Daytime sampling with midwater trawls in the Ingira-Buvuma area yielded small quantities of *Haplochromis*, *Engraulicypris* and incidental catches of other species. This indicates that at least some segment of the echo traces are caused by these fishes.

2. The results of observations with SCUBA and the absence of large fish catches from a variety of gear (beam and midwater trawls and the Lampara net) in areas with dense echo traces, infer that fish are not responsible for the bulk of these traces. The consistent lack of correlation between fish catch and echo trace density provides further evidence.

3. Although *Engraulicypris* fry cannot be discounted, it would appear based on GEE's earlier work, that a segment, possibly a large segment, of the echo traces are caused by swarms of phytoplankton. The presence of *Haplochromis* and *Tilapia esculenta* feeding on these concentrations perhaps accounts for the heterogenous appearance of the traces.

4. Evidence for the above statements is not conclusive and the possibility remains that the bulk of the traces are caused by fish.
   The traces in some respects have the appearance of typical fish traces. Also, the sampling gear seems very inefficient. For example, small catches are made at night with midwater trawls despite the fact that they sample almost the entire water column and *Haplochromis* are known to move off the bottom at that time.

5. We have not yet identified the agents causing dense echosounder traces. More extensive studies are required to achieve this goal.

In December 1970, a detailed progress report was prepared describing the outcome of these investigations and presenting recommendations for further studies. Since then our energies were diverted to follow up bottom trawling and no further work has been done on either the midwater trawl survey or identification of the pelagic echo traces.

Table I: Summary of 'IBIS' Bottom and Midwater Trawl Catches (in Kg) By Country, During 1970

Bottom Trawling					
Species	Uganda	Kenya	Tanzania	Total	%
Haplochromis spp.	75698.3	16739.9	37905.9	130344.1	75.6
Tilapia esculenta	2312.0	283.9	3387.9	5983.8	3.5
T. variabilis	542.1	3.8	47.5	593.4	0.3
T. nilotica	975.9	59.6	1476.5	2512.0	1.5
T. zillii	64.7	0.4	3.9	69.0	0.0
T. leucosticta	28.6	0.1	1.1	29.8	0.0
Bagrus docmac	6040.4	1713.3	2472.2	10225.9	5.9
Clarias mossambicus	4500.3	1879.6	2174.5	8554.4	5.0
Xenoclarias spp.	36.7	35.7	11.2	83.6	0.0
Protopterus aethiopicus	6877.8	404.0	2523.7	9805.5	5.7
Synodontis victoriae	2013.3	308.7	861.1	3183.1	1.8
S. afrofischeri	8.2	16.4	3.0	27.6	0.0
Schilbe mystus	33.9	12.8	79.3	126.0	0.1
Mormyrus kannume	239.4	8.3	16.6	264.3	0.2
Labeo victorianus	1.5	6.2	8.9	16.6	0.0
Barbus altianalis	83.4	40.5	10.9	134.8	0.1
Gnathonemus longibarbis	0.5	—	12.2	12.7	0.0
Marcusenius grahami	3.1	—	—	3.1	0.0
Lates niloticus	416.4	47.4	—	463.8	0.3
Mastacembelus frenatus	0.1	—	0.1	0.2	0.0
Clarias carsonii	—	—	0.1	0.1	0.0
Alestes jacksonii	—	—	—	—	—
A. sadleri	—	0.1	—	0.1	0.0
Barbus paludinosus	0.2	—	—	0.2	0.0
Barbus spp.	—	—	—	—	—
Engraulicypris argenteus	0.0	0.0	0.0	0.0	0.0
Total	99876.8	21560.7	50996.6	172434.1	100.0

Table I: Cont. . . . /Summary of 'IBIS' Bottom and Midwater Trawl Catches (in Kg) by Country, During 1970

Midwater Trawling					TOTAL	
Uganda	Kenza	Tanzania	Total	%	Wt. (Kg)	%
4531.9	1182.7	3708.8	9423.0	75.6	139767.1	75.6
910.4	33.2	526.5	1470.1	11.8	7453.9	4.0
45.0	3.4	8.2	56.6	0.5	650.0	0.4
109.6	3.5	14.0	127.1	1.0	2639.1	1.4
1.1	—	0.2	1.3	0.0	70.3	0.0
0.3	—	—	0.3	0.0	30.1	0.0
0.5	—	52.3	52.8	0.4	10278.7	5.6
337.0	39.1	304.4	680.5	5.5	9234.9	5.0
1.1	0.0	0.0	1.1	0.0	84.7	0.1
80.0	10.0	81.0	171.0	1.4	9976.5	5.4
17.8	—	6.5	24.3	0.2	3207.4	1.7
0.0	—	0.1	0.1	0.0	27.7	0.0
4.4	—	6.1	10.5	0.1	136.5	0.1
—	—	—	—	—	264.3	0.1
—	—	62.8	62.8	0.5	79.4	0.0
1.0	—	1.4	2.4	0.0	137.2	0.1
—	—	—	—	—	12.7	0.0
—	—	—	—	—	3.1	0.0
11.0	—	—	11.0	0.1	474.8	0.3
—	—	—	—	—	0.2	0.0
—	—	—	—	—	0.1	0.0
—	—	1.5	1.5	0.0	1.5	0.0
—	—	—	—	—	0.1	0.0
—	—	—	—	—	0.2	0.0
—	—	0.1	0.1	0.0	0.1	0.0
52.4	6.2	307.5	366.1	2.9	366.1	0.2
6103.5	1277.7	5081.4	12462.6	100.0	184896.7	100.0

Table II: Summary of 'IBIS' Bottom and Midwater Trawl Operations in Lake Victoria During 1970

	Uganda		Kenya		Tanzania		TOTAL	
	Bottom	Midwater	Bottom	Midwater	Bottom	Midwater	Bottom	Midwater
Mean catch rate (Kg/hr)	366.9	65.4	325.2	232.2	531.2	137.7	396.9	91.8
Number of Hauls made	278	92	50	7	119	39	447	138
Actual Trawling time (hrs)	272.2	93.3	66.3	5.5	96.0	36.9	434.5	135.7
Total Distance Trawled (Km)	1512.6	459.6	368.4	28.4	533.1	173.5	2414.1	661.5
Months of operation:	Jan.	June	Jan.	July	Jan.	Aug.	Jan.	June
	Feb.	July	May		Feb.		Feb.	July
	March	Aug.			Aug.		March	Aug.
	May				Dec.		May	
	Nov.						Aug.	
	Dec.						Nov.	
							Dec.	

The following indicate fields of interest during exploratory investigations:

Qualitative and quantitative comparisons of demersal and pelagic catches:

In terms of quantity, pelagic catches (especially during the day) were generally much lower than demersal catches (see mean catch rate, Table II). In terms of relative abundance *Engraulicypris argenteus* and *Alestes jacksonii* are significant, while *Tilapia esculenta* and *Labeo victorianus* appeared more significant in pelagic catches. Further, no Mormyrids, hardly any *Bagrus* and less *Protopterus* catches were made in the pelagical Zone (see Table I). In terms of vertical-spatial distribution none of the fishes in Lake Victoria are stricly more pelagic than demersal-except, of course *Engraulicypris argenteus, Alestes jacksonii* and perhaps certain species of the *Haplochromis* complex.

Conduction of 24-hr. bottom and midwater trawl series to determine diel periodicity of fishes as reflected by the catch rates.

Demersal and pelagic catch data are complementary in that some species move off, and others move to the bottom during the day but reverse directions during the night. Catch rates for *Haplochromis* spp. *Tilapia esculenta, Bagrus docmac* and *Labeo victorianus* were higher in bottom trawl hauls made during the day, but were higher in midwater trawl hauls made during the night. *Tilapia nilotica* and *Protopterus aethiopicus* were caught in higher quantities with bottom trawls during the night but together with *Engraulicypris argenteus* were caught in higher quantities during the day with midwater trawls. Mormyrid catches were mostly during the night and only in bottom trawls while midwater trawls catches for *Xenoclarias* spp. *Synodontis* and *Schilbe* occurred only during the night. The vertically opposite temporal-spatial migrations, apart from protecting against direct competitive interaction, may serve to increase the range of food items available to the species involved in this phenomenon.

Bathymetric distribution of L. Victoria fishes.

The bathymetrically eurytopic genera in the lake are *Haplochromis, Bagrus, Clarias* and *Synodontis*. Their demersal catches even in waters deeper than 50 m. were regular and commercially significant. *Tilapia* species and *Protopterus* were bathymetrically oligotopic and their demersal catches in waters deeper than 30 m. were commercially unimportant. However, the bathymetric distribution of *Tilapia* species appeared wider from pelagic catches than conceived from bottom trawl data. The average size of some fishes (*Haplochromis* spp. *Synodontis victoriae, Tilapia*) tends to increase consistently with depth.

Thus from the above there appears to exist vertieal and horizontal interspecific partial segregation in addition to intraspecific bathymetric horizontal segregation among certain species in the lake.

Comparison of qualitative and quantitative catch characteristics of the various codend mesh sizes (19, 38 and 64 mm.)

The quantities of *Haplochromis* vary inversely, and the individual size ranges vary directly with condend mesh size — as expected. Changes in catch rates and size ranges for other species cannot be directly correlated to codend mesh size.

COMMERCIAL YIELD AND LIMNOLOGICAL VARIABLES

We were most fortunate in securing the services of Dr. Henry A. Regier,* FAO Fish Stock Assessment Consultant, for a few weeks during August and September of 1970. Under his guidance, several approaches to the assessment of Lake Victoria fish stocks were examined. One approach involved a comparison of the commercial yield and certain key limnological variables for a series of East African lakes. This has been successfully applied to at least two sets of North American lakes and reservoirs, where a close relationship was found between fish yield and the "morphoedaphic index", i.e., the ratio of total dissolved solids to mean depth. This same relationship was evident for the East African lakes. It is worth quoting the tentative inference based on this exercise (REGIER, 1970, FAO of the UN, Current Problems in Assessing Lake Victoria's Stocks, Working Paper No. 1, 9 pp):

"With respect to Lake Victoria, the model indicates that per hectare yields of Nyanza Gulf should be about 3 times that of the remainder — which is consistent with our data. Another inference is that if Nyanza Gulf is now exploited at an intensity near its optimum, then one should not expect to be able to expand greatly the present yield of Lake Victoria as a whole. The scatter about the line of the model is such that a doubling of Lake Victoria's catch could be 'accommodated' by it, but a many-fold increase in catch would appear to be ruled out."

Dr. Regier has prepared a manuscript which includes not only data from the African lakes but also data for other groups of lakes from around the world. It is now being circulated among interested fishery scientists and will later be published.

COMPUTER ANALYSIS OF BOTTOM TRAWL SURVEY DATA

Another important development accruing from the visit of Dr. Regier is the computer analysis of the bottom trawl survey data. Dr. Regier arranged with Dr. Peter Larkin to carry out the necessary stepwise multiple regression programme at the computer center of the University of British Columbia. The two EAFFRO fishery biologists studying for advanced degrees at this institution will handle the programme as part of their computer training. This regression programme will yield standing stock estimates weighted by variables such as codend mesh size and time of day. Estimates will be available by lake area, country, depth of capture and substrate type.

Data from the 841 bottom trawl drags made between January 1969 and May 1970 were transfered to large sheets. After careful editing they were sent to the University of British Columbia and in very short order the data were processed and the output tables returned to us. The information is currently being analysed. Meanwhile, it became increasingly apparent that a serious gap existed in our bottom trawl survey; i.e. the lack of catch data for small-mesh codends, particularly the 19 and 38 mm. sizes. Accordngly, a series of cruises were scheduled, starting in November 1970, to remedy this deficiency. Three cruises have been completed and the final one will be finished in early March 1971. These data will be assembled and sent to the University of British Columbia, and the computer programme will be run. The new data should materially strengthen the multiple regression analysis.

FISH TAGGING

Tagging commenced on October 8th, 1970 and continued on October 13th and 14th when we tagged fish caught by the midwater trawl in Buvuma Channel and Ingira Bay. A total of 150 fish were tagged which included 138 *Clarias mossambicus*, 5 *Synodontis victoriae*, 2 *Tilapia nilotica* and 1 *Protopterus aethiopicus*. When released from the codend, they were immediately placed in a small holding container sitting on the deck of the "IBIS" through which a flow of water usually was maintained. After the fish remaining on the deck were processed, we tagged fish held in the container. All fish were in excellent shape indicating that half-hour hauls with the midwater trawl will provide fish in suitable condition for tagging.

Additional comments and recommendations are as follows:

1. The publicity programme required to make this tagging programme a success will be started immediately.
2. The fish were tagged successfully without the use of an anaesthetic. A hypodermic needle inserted through the side into the air bladder will probably work to release excess gas for those species unable to adjust to rapid pressure changes when brought to the surface. *Bagrus* will pose the biggest problem in this regard.

3. The Floy tagging gun and the large red tags (FD-68B) with the monofilament passing entirely through the vinyl tubing worked very well. Another 4,000 were ordered and have since arrived (2,000 blue and 2,000 green).

4. The small blue and yellow tags with the monofilament attached at the base of the vinyl will be useful only for tagging relatively small fish. Under pressure, the vinyl readily separates from the monofilament. If the vinyl itself enters the flesh, a large wound will probably result.

5. A better tagging cradle should be devised and improved holding tanks and dip nets should be built. The newest tagging record form appears adequate.

6. Aquarium tests of the tags using several species (*Tilapia, Clarias, Bagrus* and *Protopterus*) would be desirable.

7. *Clarias* should be tagged under the dorsal fin, about half-way between the origin and the insertion to insure placement of the T-bar behind the interneural bones. Two tag returns have been recorded for *Clarias* thus far. There was no obvious migration involved. The tags and the fish were in good condition; there was no evidence of tissue damage.

We have not tagged any fish since October. This work was integrated with the midwater trawling survey and when the survey ceased so did the tagging programme.

A LIMNOLOGICAL SURVEY OF LAKE VICTORIA FOR THE PERIOD JANUARY TO DECEMBER 1970

G.E.B. KITAKA

In general, limnological data continued to be collected along the lines established at the inception of the programme, namely from permanent inshore and offshore stations, and from along transects run in different directions across the lake.

The routine hydrological stations were sampled about once a month, when vertical profiles of temperature, dissolved oxygen, pH, phytoplankton densities, PO_4, NO_3, NH_4, SiO_2 and SO_4 were measured, and vertical zooplankton hauls made. A column of water from the top 20 metres was also collected every time for the assessment of the seasonal variation of the phytoplankton density in the euphotic zone.

Along the transects made, temperature and dissolved oxygen vertical profiles were the two parameters that were always measured. However, whenever time allowed, vertical zooplankton hauls were made and phytoplankton water columns from the euphotic zone collected at some of the stations of the transects. Unfortunately, due mainly to the unavailability of the research vessel 'IBIS' regular data collection could not be effected throughout the year.

The first transect was made in January, from the mouth of the Karera, River, north-eastwards via Hunter Rock to Hannington Bay. The transect was made at the end of a complete week's hydrological and fishing survey of Kagegi Gulf and the area immediately south of Sese Islands. It was found that whereas the water column was isothermal and the oxygen and pH conditions ideal nearly throughout this area, there was strong stratification and poor oxygen conditions in the deeper waters east of Sese Islands, a fact that tends to militate against interpreting the hydrology of the entire lake from measurements taken at any one point in the lake.

The second transect was run from West to East in July, and the third from North to South in August, across the middle of the lake in both cases. The results of these two transects confirmed earlier observations that this period (July-August to September) is the period of complete overturn of the lake when ideal dissolved oxygen conditions obtain throughout the entire water column. The oxygen saturation varied between 100% at the surface and 80% at the bottom.

The stratification cycle of the lake, as seen from the results of the routine hydrological stations did not vary much from the normal. From September of 1969 to May 1970, slight vertical gradients of temperature, dissolved oxygen, pH and the chemical nutrients measured developed throughout most of the water column, but the severest conditions of deoxygenation in the bottom waters were reached in March when a strong smell of hydrogen sulphide was detected for the first time at Hunter Rock station between 50 to 64 metres depths. However, this stratification began to break down much earlier than usual in the first week of May, leading to an unusually extended period of isothermal mixing from June right up to the end of October when the initial stages of restratification were first detected.

The highest concentrations of phytoplankton within the euphotic zone were recorded in September instead of August as is normally the case, but the zooplankton did not show any definite peak of production throughout the year.

It is now becoming more and more apparent that in order to evaluate the impact of various hydrological factors on the distribution of fish populations in the lake, it would be necessary to concentrate on a particular area of the lake and sample it as often and regularly as possible rather than to try and cover the whole lake which is impossible to sample so regularly. It is hoped to concentrate on this when a second research trawler becomes available.

MATURITY, SEX RATIO AND FECUNDITY OF THE LUNG FISH *(Protopterus aethiopicus* Heckel*)* FROM LAKE VICTORIA

J. OKEDI

INTRODUCTION

Recent trawling surveys in Lake Victoria by the UNDP/FAO and EAFFRO using the Research vessel 'IBIS' have shown that the Lung fish *(Protepterus aethpicus)* is widely distributed in Lake Victoria. It is abundant and occurs even in the deeper offshore waters. It is readily caught in waters 0-30 metres deep but becomes uncommon in waters 40-50 metres deep. Its scarcity in waters more than 50 metres deep is probably related to its breathing requirements which necessitate surfacing regularly to breathe atmospheric air.

Most of the specimens caught in the trawls were large and full grown adults. Immature fish were not caught and this agrees with the breeding habits of *Protopterus aethiopicus* as described by GREENWOOD (1958). The Lung fish breeds in shallow swampy areas where it makes elaborate nests and actively guards its young. However the presence of large numbers of adults in offshore waters indicate that they are most likely subject to periodic migration to the littoral swampy areas of the lake for breeding.

During these observations standard length of *P. aethiopicus* was found difficult to determine and measure. This was because the caudal peduncle is not distinguishable as it is fused with the elongate dorsal and anal fins. Anal length was therefore considered a suitable substitute for standard length and was measured from the tip of the snout to the anus. The position of the anus was, however, variable, occurring either on the left or right side around the pelvic region of the body. Hence total length was easier to measure but sometimes the tail fin was missing in some specimens and this was thought to have come through damage in early development or perhaps predator attack. However both anal and total length were measured in all specimens except those which were maimed.

This report therefore describes certain aspects of the breeding of the Lung fish *(Protopterus aethiopicus)* in Lake Victoria which hitherto had not been previously elaborated.

FECUNDITY

GREENWOOD (1958) examined several female *Protopterus aethiopicus* and found oviducal eggs numbering between 1700-2300. However he found some 5190 larvae of the Lung fish in one nest. During my observations, a total of 189 ovaries from ripe female *P. aethiopicus* have been examined. A mean number of ova in the ovary was 8960 but ranging from 468 to 58422. No ova were found in the oviducts and this is perhaps due to the fact that all the specimens were taken from the offshore waters away from their breeding grounds.

The smallest fish from which ova were counted was 36.0 cms. anal length (total length 68.0 cms.) and yielded 3546 ova. The largest specimens (86.0 cms. anal, 117.0 cms. total length contained 30550 eggs in its ovaries. There was significant variability in the ovarian counts even from fish of the same size. However it was obvious that egg number increased with length of female. The female with the highest ovarian count was not necessarily the largest as shown by the fact that a total of 58422 eggs were derived from a fish of 48.0 cms. anal length (total length 91.0 cms.), weighing 2400 gms. The majority of females contained less than 20,000 eggs and only three fish had more than 30,000 eggs in their ovaries.

The ovary in *P. aethipicus* is bifid and its coloration largely depends on its state of sexual maturity. A young developing overy is dull brown whereas a ripe one is dull green.

EGG SIZE

Egg measurement was carried out from all the females examined where ten eggs each from the three sizes were measured for every ovary. Egg size was found to be variable, each ovary often containing eggs of several sizes.

Size	Diameter Mean (mm)	Diameter range (mm)	No. Females examined
III	3.88	3.1-4.7	189
II	2.22	1.5-3.0	189
I	1.37	1.0-1.5	189

There were generally three egg sizes as shown in the above Table. Well developed ovaries contained predominantly the large green ova measuring between 3.1-4.7 mm. although mean diameter was about 3.88.

These ova are spherical and contain heavy deposits of whitish rather milky fluid. GREENWOOD (1958) reported finding many well developed ova lying free in the oviducts. No oviducal ova were seen in these specimens and the matured ova were all taken from the ovary where they were attached to the ovarian membrane. Preservation of these ova proved difficult because of the presence of large amounts of a milky fluid mentioned above. Using Gilson's fluid, they took too long to harden and did not preserve well. High concentration of formaldehyde (10%) was therefore used followed by dying with electric light.

The next size of eggs were oocytes 1.5-3.0 mm. in diameter, mean diameter being 2.22 mm. These oocytes predominate in ovaries which are developing to sexual maturity. They are few in ripe ovaries and are often coloured pinkish green. Small oocytes are often found even in ripe ovaries. These are 1.0-1.5 mm. in diameter and are pink in colour. Smaller oocytes less than 1.0 mm. were also seen but these were not counted.

SEX RATIO

In adult specimens examined by GREENWOOD (Op. Cit.) 96 were females but only 29 were males. He further observed that in the immature stages, females were in excess of males. My specimens were largely caught in the open waters by bottom trawls and a few by gill nets. The females were 836 and males were only 485 giving a ratio of 63.3% females against 36.7% males. There is obviously significant divergence from the expected 50% distribution ($X^2 = 93.2$ and $P = < 0.001$). It was observed too that the males grow larger than females. However, more observations are necessary to determine the causes of this divergence in sex ratio.

SEXUAL MATURITY

GREENWOOD (Op. Cit) mentioned that female *P. aethiopicus* reach sexual maturity at a length of between 65-70 cms. and the smallest sexually mature female was 61 cms. whereas the largest was 98 cms. Greenwood did not mention whether he was dealing with total length or standard length but it is more probable that he was referring to total length. He further stated that the length at which males mature was unknown. In the specimens examined here the smallest sexually ripe female was 38.0 cms. anal length (total length 76.0 cms) weighing 1,900 gms. If Greenwood's length was total length, then the present data confirm that female *P. aethiopicus* attain sexual maturity at about 65-76 cms total length. In my specimens, the smallest sexually mature male was 82 cms total length (anal length 43.5 cms) and weighing 2,400gms. It is indicated therefore that females attain sexual maturity at smaller lengths than the males. This may be related to the higher growth rate of males and this corroborates earlier observations that male *P. aethiopicus* grow larger than the females.

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ON THE FISH SPECIES OF LAKE BARINGO

SSENTONGO, G.W. and MANN, M.J.

INTRODUCTION

The Cambridge expedition to the East African lakes 1930-31 recorded only 4 species of fish from Lake Baringo and its affluents:
Tilapia nilotica (Linne) 1757, *Barbus gregorii* Boulenger 1902, *Clarias mossambicus* Peters 1852 and *Labeo cylindricus* Peters 1852. WORTHINGTON and RICARDO (1936) commented that Lake Baringo might be expected to posses a nilotic fish fauna like Lake Rudolf. This theory is now discounted partly because the prehistoric Lake Kamasia is now considered to have been less extensive (McCALL, BAKER and WALSH 1967) and Lake Baringo has only *Tilapia nilotica* in common with Lake Rudolf.

Alternatively, WORTHNGTON and RICARDO (1936) suggest that the fish fauna of Lake Baringo could have been derived from the headwaters of Ewaso Nyiro, Tana and Athi rivers. These rivers lie close to the Lake Baringo basin and there is evidence of recent river capture.

In this report consideration is given to fish species composition and their distribution arising from a survey conducted in 1969. Some growth characteristics and gillnet selectivity data for the exploited fish populations, are also given.

Barbus gregorii Boulenger 1902

WORTHINGTON and RICARDO (1936) noted that *Barbus gregorii* was abundant all over the lake and grew to a length of 19.0-68.0 cms. During the survey 515 specimens ranging from 8 cms to 35.3 cms (standard length) were caught in gillnets from various localities of the lake. MANN (in press) comments that *Barbus gregorii* is probably a member of the widespread and polymorphic *Barbus tanensis* complex and the comparison made between juveniles from the Tana River and Lake Baringo supports this view.

The highest catch of *Barbus gregorii* occurred in the 2.9 cms gillnets and the catch declined with increase in mesh size up to 10.2 cms mesh size. But the 12.7 cms mesh caught some large old *Barbus* which had grown beyond the selection range of the commercial 10.2 cms gillnets. In open waters, bottom set gillnets caught more *Barbus* than top-set gillnets. This distribution is expected of a predominantly bottom-feeding species. The catch of *Bargus gregorii* was greater in the inshore waters than in the offshore waters. The ratio of males to females is 1.2:1. Both sexes occur over a similar size range. Both males and females reach sexual maturity at a mean standard length of 10.4 cms.

Table 1 shows the different lengths of *Barbus gregorii* selected by gillnets of different sizes. The wide length range of fish caught in each mesh size might be explained by the fact that *Barbus* spp. are rarely cleanly gilled but are usually entangled in the gillnets.

Table I: Gillnet selectivity data for *Barbus gregorii*
(standard length in cms)

Mesh size cms	Number of settings	Number of fish/setting	minimum length cms	maximum length cms	mean lentgh cms
2.9	4	29	8.0	17.4	10.0
3.8	6	13.5	9.9	16.0	12.4
5.1	8	22.0	10.0	26.4	15.9
6.4	4	12.5	12.6	25.8	19.4
7.6	5	12.0	19.2	38.5	24.3
8.9	3	4.0	9.9	53.5	28.6
10.2	10	1.2	14.4	38.5	23.8
11.4	6	0.3	23.0	28.0	25.5
12.7	4	2.0	8.5	50.0	29.2

Barbus gregorii is of secondary importance in the commercial gillnet fishery but is of greater significance in the commercial and subsistence rod-and-line fisheries.

GREENWOOD (1962) reports the presence of *Barbus amphigramma* Boulenger 1903, *Barbus kerstenii kerstenii* Peters 1868, and *Barbus loveridgii* Boulenger 1961. During the survey none of these species was identified.

Barbus lineomaculatus Boulenger 1903

MANN (in press) comments on the identification of this species recorded for the first time from Baringo and Hannington basins; no specimens were collected from the Sugota River at Karpeddo.

The small and commercially unimportant fishes ranging between 1.9-5.8 cms standard length predominated in the lower reaches of the affluent rivers where they were collected by mosquito-seine nets but some large specimen ranging between 4.4-6.2 cms occurred in beach seine hauls and were present with the gillnet catches from the lake itself. Specimens from the gorge at Sandai ranged between 4.3-6.6 cms in standard length.

Labeo cylindricus Peters 1852

Specimens of *Labeo* from Lake Baringo and the Waseges River (Hannington basin) have previously been recored as *Labeo cylindricus* (WORTHINGTON and RICARDO 1936).

The mesh selection data in Table 2 shows that the catches of *Labeo cylindricus* were restricted to the smaller meshes and it was noted that the highest catches were obtained from bottom-set gillnets adjacent to the rocky shores of Parmalok island.

Labeo cylindricus is not captured in the 10.2 cms gillnets of the commercial fishery. It is not caught by the rod-and-line nor by any riverine traps primarily set to exploit upstream migrating species. The catches of *Labeo* in Lake Baringo were considerable in small mesh (3.8 cms) bottom set gillnets, along the rocky shores.

If *Labeo* is carefully proeessed, perhaps by smoking it might form a useful addition to the commercial fishery. Gillnets of small mesh size (e.g. 3.8 ems) when bottom set in habitats suitable to *Labeo*, are unlikely to have any adverse effects upon the stocks of *Tilapia*, *Barbus* and *Clarias*.

Table 2: Gillnet selectivity dat for *Labeo cylindricus*
(Standard lengths in cms)

Mesh size cms	number of settings	number of fish/setting	minimum length cms	maximum length cms	mean length cms
2.9	4	92	9.1	19.6	10.8
3.8	6	35	11.5	16.1	11.6
5.1	8	10	9.1	20.2	15.8
6.4	4	3	12.6	19.0	16.8
7.6	5	0	—	—	—
8.9	3	0	—	—	—
10 2	10	0	—	—	—
11.4	6	0	—	—	—
12.7	4	0	—	—	—

Claris mossambicus Peters 1852

Specimens of *C. mossambicus* have been collected from Lake Baringo and its affluent rivers, the Waseges River (Hannington basin), and from the Sugota basin at Karpeddo. No critical taxonomic examination has been made of these specimens. WORTHINGTON and RICARDO (1936) consider that the specimens of *Clarias* from the Baringo and Hannington systems are best regarded as *C. mossambicus* which is widely distributed over eastern Africa, although the same authors note that the very closely related *C. lazera* replaces *C. mossambicus* in Lake Rudolf just to the north. JUBB (1968) has critically examined members of *C. gariepinus* and *C. lazera*, maintaining that the distinction between *C. gariepinus* and *mossambicus* is not valid, and that these 3 species may simply represent geographical varieties of a single extremely widespread species.

The gillnet selectivity data given in Table 3 indicates the relatively rare occurrence of *Clarias* in gillnets, and the fairly wide range of size caught in each mesh size implies that both entanglement and gilling occur. As noted by WORTHINGTON and RICARDO (1936)' *Clarias* occur all over the lake.

Table 3. Gillnet selectivity data for *Clarias mossambicus*

mesh size cm	number of settings	number of fish caught	number/ setting	minimum length cm	maximum length cm	mean length cm
2.9	4	0	—	—	—	—
3.8	6	0	—	—	--	—
5.1	8	6	0.8	20.5	51.0	27.3
6.4	4	6	1.5	21.0	28.4	26.0
7.6	5	2	0.4	30.8	39.9	35.4
8.9	3	1	0.3	37.1	—	37.1
10.2	10	4	0.4	40.6	43.1	41.9
11.4	6	3	0.5	43.6	46.6	44.5
12.7	4	0	—	—	—	—

Insufficient data was collected to provide a reliable weight length relationship. But it was observed that all adult *Clarias* caught were in poor condition with large heads and remarkably emaciated bodies.

At present nothing is known on the growth and maturity rates of *Clarias mossambicus* in Lake Baringo. Though in most East African lakes *Clarias* is of considerable commercial value, in Lake Baringo the very low population density and the poor conditions of individual fishes, make *Clarias* of little commercial value.

Aplocheilichthys sp.

MANN (in press) discusses the identification of the cyprinodont genus collected during the survey. LEAKEY (1969) had previously sent cyprinodont material from the Lake Baringo basis to the British Museum of Natural History for identification. GREENWOOD (1970) indicated that *Northobranchius* sp. has been recorded in a collection from the Lake Baringo basin.

During the snrvey several hundred specimens of *Aplocheilichthys* ranging from 1.4 cms to 2.1 cms (standard length) were collected from minor rapids, shallow pools and muddy backwaters at the Perkerra barrage on the Tigeri (Barger) River. *Aplocheilichthys* were also taken at the Molo crossing south of Perkerra and again farther downstream near Longumkum.

Within Lake Baringo, a number of specimens ranging from 1.7 to 2.5 cms (standard length) were collected from stagnant swampy pools among thick stands of *Typha* near Kamp-ya-Samaki.

Tilapia spp.

Tilapia esculenta, Tilapia spilurus nigra and *Tilapia melanopleura randalli* have all been introduced into highland dams within the Baringo system but no example of these species were identified during the survey.

Tilapia nilotica (Linnaeus) 1757

TREWAVAS (1933) identified *Tilapia* from Lake Baringo as *Tilapia nilotica.* During the survey, no other species of *Tilapia* was identified. The dark coloured *Tilapia* of a non-indigenous species noted in the Kenya Report 1966, probably represented mature male *Tilapia nilotica* which are slate-grey when alive but which darken rapidly upon death and dessication.

During the survey gillnets of mesh size ranging from 2.9 cms to 12.7 cms were set. The catch of *Tilapia nilotica* was higher in the shallow inshore waters than in the deep offshore water. In open waters, bottom set gillnets caught twice as many fish as surface set gillnets.

Tilapia nilotica in Lake Baringo grow to a smaller size than the *Tilapia nilotica* in several East African lakes (LOWE 1958, GREENWOOD 1966). During the survey the largest *Tilapia nilotica* encountered was 35.8 cms total length and weighed 794 gm. The largest *Tilapia* recorded by WORTHNG-TON and RICARDO (1936) was 36.0 cms.

The growth characteristics of *Tilapia nilotica* in Lake Baringo are not known. In Lake George, the maximum length (L ∞) is 40 cms and the length at maturity (lm.) is 28 cms. In Lake Rudolf L ∞ = 64 cms and lm. = 39 cms (SSENTONGO 1971). The small *Tilapia nilotica* of Lake Baringo with a maximum length (L ∞) of about 36 cms and which mature at about 18 cms, have a low ratio (lm./L∞) of 0.50. HOLT (1962) found correlations between the ratio lm./L ∞ and the growth rate (K). Fish with a low ratio (lm./L ∞) have a high growth rate. It is therefore very likely that *Tilapia nilotica* in Lake Baringo has a higher growth rate and a shorter life-span than *Tilapia nilotica* in Lake George, Lake Albert and Lake Rudolf.

The gillnet selection characteristics of both experimental and commercial gillnets are given in Table 4.

mesh size cm	number of fish	Standard length cm minimum	maximum	mean
2.9	42	5.8	10.6	6.4
3.8	42	7.0	12.3	8.6
5.1	286	6.6	14.2	10.7
6.4	136	10.2	19.2	13.9
7.6	154	10.5	19.9	15.9
8.9	163	12.0	21.5	18.5
10.2	146	9.5	23.8	16.6
11.4	11	9.8	24.3	17.8
12.7	2	11.7	21.0	15.0

The size range of fish taken in commercial gillnets of 10.2 cms mesh is 8.2-25.5 cms with a mean standard length of 16.6 cms.

The males were found to be less numerous than the females, the ratio being 1:1.5. but WORTHINGTON and RICARDO (1936) reported that the ratio of males to females was 3:1.

Several factors may be responsible for the small size of *Tilapia nilotica* in Lake Baringo. LOWE (1958) suggests that adequate food supply is a factor of major importance and that epiphytic diatoms are an important item in the diet. *Tilapia nilotica* is the most important commercially exploited fish species in Lake Baringo. The growth and mortality rates and the age distribution of *Tilapia nilotica* are not known.

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IDENTIFICATION OF "ORGANISMS" IN LAKE VICTORIA RESPONSIBLE FOR ECHOSOUNDER TRACES

J. CORDONE & BILL A. KUDHONGANIA

INTRODUCTION

At a meeting on September 11th, 1970 it was decided that the highest priorities for the field programme through mid-1971 should be allocated to the completion of the midwater trawl survey of the pelagic zone and the initiation of a tagging study. Before the survey was to begin again however it was agreed that the "organisms" responsible for the dense traces appearing on the echosounder tapes should be identified. Unless this were done, we had little faith that midwater trawling was yielding meaningful results. The purpose of this report is to deseribe the progress made thus far in identifying the traces. Progress has been hampered however because of the time required to construct the various test nets and to repair the main auxillary engine on the '*IBIS*' which suffered a major breakdown. Also, it was recently decided to undertake several additional bottom trawl cruises to remedy some critical deficiences in the data.

MIDWATER TRAWLING

Midwater trawling on a limited scale was carried out in the past on Lake Vietoria. The work comprised experiments with both midwater and surface trawls in the mid-1960's (GEE and GILBERT 1967). The study area was located in waters off Jinja and Entebbe. Results were considered inconclusive since fishing effort was limited and gear problems forced abandonment of the project. Midwater trawling in particular was deemed unsuccessful since very few fish were caught; *Haplochromis* and *Engraulicypris* being the main constituents. Surface trawling was somewhat more promising, yielding an overall catch per hour of about 10.7 kilograms. *Haplochromis* constituted 90% of the catch with *Alestes jacksonii*, *A. sadleri* and *Engraulicypris* being the only other species which occurred regularly. This is surprising sinee the only specimens of *Alestes* captured under the present midwater trawling programme were taken in Speke Gulf.

Midwater trawling under the present programme refers to deployment of midwater trawls at any level in the water eolumn from the surface to just off the bottom. All mesh sizes mentioned are given in stretched measure. Two different trawls were used almost exclusively during the three eruises eompleted thus far in 1970; one with a headrope length of 30 metres and a fishing height of 12 metres and a second with a 27-metre headrope length and a height of 8 metres. When fishing, the actual horizontal opening of these nets apparently varies between 8 and 10 metres whereas the full vertical height is attained. Thus, these nets strain a very large volume of water, but because of their size and the weight of the doors they cannot be towed faster than 2.5 knots without seriously overloading the engine. Actually the end result conforms to current midwater trawling practices; i.e., a very large net towed at slow speeds. The codend used most often had a mesh size of 20 mm.

The combined results of 118 midwater trawl drags are given in Table 1. Only data for hauls made with the 30- and 27 metre trawls and utilizing the 20- mm. mesh size codend are shown. The catches are substantially lower than bottom trawl catches in which the same mesh size codend was used. About 50% of all hauls yielded less than 75 kilograms per hour and 75% of the catch was made up of *Haplochromis* species. The contribution of other species was generally low and varied greatly from one lake area to another. The catches in general varied enormously as can be ascertained from the values in Table I for range and standard deviation.

TABLE 1

Summary of Catches Made with the 30- and 27-Metre Midwater Trawls on Lake Victoria; 20-mm. Mesh Size Codend Only

Item	Night hauls (50)		Day hauls (68)	
	All fish	Haplochromis	All fish	Haplochromis
Mean kilograms per hour	124.2	98.2	82.5	63.8
Range	4.6-427.6	2.9-304.5	3.7-541.6	1.6-529.2
Standard deviation	96.9	71.0	102.7	94.8
Standard error of the mean	13.7	10.0	12.5	11.5
95% confidence limits	97.3-151.1	78.6-117.9	58.1-107.0	41.3-86.3
Kilograms per hectare [1]	29.8	23.5	19.8	15.3
Kilograms per 10,000 cubic metres[2]	3.7	2.9	2.5	1.9

1 A 9-metre trawl opening is assumed and trawl height is ignored.

2 A trawl opening of 9 metres and a height of 8 metres are assumed. The fishing height of the 27-metre trawl was used since this net was used most often (61% of all hauls).

A misleading impression of fish densities is gained from the hourly catch rate data since the large volume sampled is ignored. Conversion of catch rates to yields per unit volume of water strained (10,000 cubic metres is the basic unit) indicates very sparse fish densities in the pelagic zone (Table 1). This was not surprising since during the three cruises, few traces on the echosounder could be detected in midwater; the echosounder was operating almost continuously when the '*IBIS*' was underway. On those few occasions when traces were observed, the catch rates generally did not show an increase. This led to skepticism regarding the suitability and efficiency of both the trawls and the echosounder. During this period, a number of modifications of the trawls, rigging and procedures were instituted in an attempt to increase the catching powers of the midwater trawls. Tested were (i) towing speed within the limits imposed by the combined weight of the net and the doors, (ii) bridle arrangement and length, (iii) weight variations and angle of attack of the doors, and (iv) a new midwater trawl. The latter was smaller than the others, had smaller mesh in the wings, a more gradually tapering configuration and a 13-mm. mesh size codend. None of these modifications appreciably altered the pattern of relatively low fish catches using midwater trawls in the pelagic zone.

From at least two standpoints, the results of the midwater trawling seemed reasonable. First, neatly contrasting with the pattern shown by bottom trawling, day versus night sampling with midwater trawls demonstrated higher night than day catches of *Haplochromis* (Table 1). They apparently move off the bottom at night and thus become more susceptible to capture in midwater trawl gear. On two occasions, 24-hour trawling series along the same transect provided further documentation of this phenomenon. Virtually all other species were captured at higher rates during night hours also, according to result of the 24-hour work. Nevertheless, night catches still were lower than one would expect considering the large net opening and the fact that for some hauls the fishing height covered almost the entire water column from the surface to within several metres of the bottom. However, although we know that *Haplochromis* disperse from the bottom at night, we do not know what pattern this movement takes; i.e., how far off the bottom they move and in what concentrations. Second, although the daytime midwater trawl catches of *Haplochromis* are probably lower than they should be, the species caught appeared to be different from those taken at night. The latter are similar to those taken in bottom trawls which again reflects nocturnal movement off the bottom. Thus, in daytime trawling we are probably catching what is available in midwater (this includes mainly the pelagic *Haplochromis* and *Engraulicypris*) but perhaps with very low efficiency.

A second echosounder was installed on the '*IBIS*' in August. It seems more sensitive than the original, and displayed very dense traces throughout the bays and channels from Jinja to Buvuma Island. Sampling was concentrated in these areas in an attempt to identify what was responsible for the traces. The traces have remained in this region throughout the study period. They tend to be more dense in bays like Ingira and Hannington than in channels like Buvuma and Napolean Gulf. In general they are darker and more dense near the bottom. When the '*IBIS*' is underway at trawling speeds from 2.5 to 3.5 knots, the traces appear to project irregularly from the bottom as spears or pinnacles. The edges of these projections are fuzzy rather than sharp, and the heights vary considerably within relatively short distances. The appearance of traces detached from the substrate (true pelagic traces) vary greatly in size, shape and density. However, they are definitely vertical in orientation and usually have a plume or comet-shaped configuration. At times, definite horizontal layerings of traces can be seen. Superficially there seemed to be little day versus night difference in the appearance of the traces.

Using the 27-metres midwater trawl with the 20-mm. mesh size codend, three hauls were made on October 8th and nine hauls on October 13th and 14th in the Ingira Bay-Buvuma Channel area. The first haul made in the early morning hours of October 8th resulted in a record catch for midwater; about 1000 kilograms of *Haplochromis*, 300 of *Clarias mossambicus* and a few *Xenoclarias* and *Synodontis victoriae*. The next haul was a half hour also and was made in the same area but during daylight and the catch declined appreciably: about 150 kilograms of *Haplochromis*, 50 of *Clarias* and several specimens of other species. The final drag yielded only a few kilograms of fish, mostly *Haplochromis*. For the remaining nine hauls, the daytime catches ranged from about 40 to 70 kilograms per half hour and the night-time catches from 100 to 150. These catches, although somewhat higher than the average, did not resolve the question of the identification of the traces. If fish were responsible, then they must have been able to avoid the trawl, and sight is implicated since the catch increases at night when fish are less able to detect the trawl.

HIGH-SPEED BEAM TRAWL

If the traces are fish, then they are either able to avoid the trawls or the traces are being misconstrued and the fish are not as abundant as they appear on the tapes. To clarify the former possibility, the Masterfisherman constructed a beam trawl which permits towing speeds to 4 or 5 knots without critical pressure-wave buildup. This trawl does not use doors but instead the opening is maintained by a rectangular pipe frame measuring

4-metres wide and 2.5-metres high. A long, gradually-tapering net was fitted to the frame and the usual 20-mm. mesh size codend was attached.

Ten hauls were made with this net on October 21st and 22nd at various locations in Itome, Ingira and Thruston bays where dense traces were observed on the echosounder. Daytime catches as usual were very low, consisting of a few kilograms of *Haplochromis*. Night hauls increased as expected but not to very high levels; 100 to 150 kilograms per half hour at the most. An unusual catch was 50 kilograms of *Engraulicypris* from a half-hour haul in Itome Bay. Daytime bottom trawl eatches of 1,000 to 1,500 kilograms of *Haplochromis* per hour were made at about the same time and vicinity as the beam trawling. This indicates dense quantities of fish in the area which makes the relatively low night-time catches difficult to understand. Although the beam-trawl has a smaller opening than the bottom trawls it is towed at a faster speed; usually between 4.0 and 4.5 knots. Thus the greater distance covered by the beam trawl compensates in large measure for its smaller opening and the catch rates for both types of gear are fairly comparable.

Skis were added to the beam trawl so it would slide over the bottom without hanging-up and permit sampling close to the bottom where the most dense traces were observed. On October 30th, four daylight hauls were made with the beam trawl on the bottom in the usual areas where dense traces were found; Ingira Bay, Buvuma Channel and Napolean Gulf. The hourly catch rates ranged from 300 to 400 kilograms of *Haplochromis*. Hourly catch rates from four hauls made in the same manner on November 16th and 17th in Pilkington and Hannington bays ranged from about 125 to 450 kilograms of *Haplochromis*. Converted to a unit area basis these catches average about 135 kilograms per hectare, whereas by volume they average about 50 kilograms per 10,000 cubic metres. The former are about one half and the latter are about one third the corresponding averages for bottom trawl catches made with the 24-metre net using the same 20-mm. mesh size codend.

The relatively low yields with the beam trawl fished on the bottom is puzzling. It may be that the absence of otter doors is responsible. When used with standard bottom trawls the doors may stir the substrate tending to obscure the oncoming trawl and thus rendering fish more susceptible to capture. The beam trawl is used without doors and the wire warp alone may not provide sufficient agitation and thus fish would be better able to detect and avoid the trawl. For this to occur, it would have to be assumed that the fish also are able to escape a net towed at speeds between 4.0 and

4.5 knots. This does not seem likely since, if the traces reflect fish, there is probably an abundance of them and they would most likely be small *Haplochromis* and *Engraulicypris* (the mean size for both genera probably ranges between 5 and 10 centimetres). Perhaps a more likely explanation is that the skis prevent the trawl from scraping the bottom and instead maintain about a half-metre space between the substrate and the net-opening. If the *Haplochromis* are as bottom oriented as is suspected, then this space could account for the relatively lower beam trawl catches. On several occasions, the Masterfisherman has constructed and tested bottom trawls with greater fishing heights. Enhanced catches did not accrue which suggests, assuming the trawls fished as anticipated, that *Haplochromis* are closely associated with the substrate during daylight hours and that perhaps the traces projecting from the bottom are not caused by fish. Insight into this question could be gained by comparing beam trawl catches both with and without the presence of otter doors.

LAMPARA NET

A small Lampara net was built by the Masterfisherman to aid in identifying "organisms" responsible for the dense midwater traces, to obtain fish for tagging and for training of the crew. The handling of this net presents problems similar to those of the purse seine which will be used extensively in the future. The net was 56-metres long and 12-metres deep and had 10-millimetre webbing in the bag and 29-millimetre webbing in the wings.

It was fished for the first time in the afternoon of September 29th. Two hauls were made in Napolean Gulf but very low catches were recorded. Three additional hauls were made in Ingira Bay on September 30th where abundant traces were observed on the echosounder. The net was set in a circle from two small boats. The first set was made in water about 8-metres deep and the next two in progressively shallower water. The third haul was made right against papyrus plants at a depth of about 2 metres. In each case the catch was low. Between 4 and 12 kilograms of *Haplochromis* spp. and a few *Xenoclarias* spp. were caught in each haul, but no fish large enough to tag. Also, a large amount of mud fouled the shallow set which presents difficulties in operating a purse seine in some shallow water areas.

Because of the small size of the net, which surrounds an area of only 0.025 hectare, it was decided to attach 30 metres of netting to each of the wings. This increased the length of the Lampara to 116 metres which encloses an area of 0.11 hectare. Several sets were made on October 7th, 8th and 13th in Hannington and Ingira bays where dense traces were noted on the echosounder. Again low catches were recorded and no fish taken of a size suitable for tagging. Small *Haplochromis* continued to dominate the catches except for two night sets made around an electric light which was left on for about one hour before each haul. Here the largest catch consisted of about 6 kilograms of *Engraulicypris argenteus* and 1.5 of *Haplochromis*. The echosounder indicated abundant traces in the area of the light when the night sets were made.

In one respect, the low catches in the Lampara net are not surprising. Although theoretically covering an area of 0.11 hectare, the actual area encompassed is less than this since ends of the wings are pulled off the bottom to complete pursing the net. Thus, catches between 5 and 10 kilograms per set yield standing stock estimates of between 50 and 150 kilograms per hectare. This is less than the estimated 200 kilograms per hectare which is based on bottom trawl catches using a 20 millimetre mesh-size codend. There is certainly ample opportunity for fish to escape this net before it is fully pursed.

It does not appear that the Lampara will assist in either identifying traces in the pelagic zone or providing fish for tagging purposes.

PLANKTON STUDIES

Efforts in utilizing this technique to identify the echosounder traces have been extremely limited. Four daytime midwater trawl catches in locations where traces are abundant and dense may mean that the "organisms" responsible are not fish. Concentrations of zooplankton or phytoplankton or even clouds of sediment stirred off the bottom by the activities of large fish may be responsible.

George Kitaka made two vertical hauls with large plankton nets in Ingira Bay on October 7th. The dense traces through which the nets were drawn apparently were not caused by zooplankton since so very few were caught. Sampling was too limited however to justify drawing conclusions and of course the phytoplankton were not sampled since the mesh size was too large.

Much more work is required before the role of Lake Victoria plankton in producing echosounder traces can be elucidated. Studies elsewhere have demonstrated that dense zooplankton populations can be discerned by echosounders. At Lake Victoria, typical zooplankters such as cladocerans and copepods are not considered particularly abundant. However, lake flies *(Chaoborus* or *Chironomus)* emerge in great concentrations at times. When in midwater they probably would show up as echosounder traces. *Chaoborus* is not only abundant in some areas but performs a diel vertical migration through the water column which the echosounder likely would record. Phytoplankton are believed to be very dense in Lake Victoria and also might appear as traces.

SCUBA STUDIES

The use of SCUBA (Self-Contained Underwater Breathing Apparatus) in conjunction with a sampling programme to make final identification would seem like the most efficient means of identifying the traces. The advantage of SCUBA is tempered by the general lack of clarity of Lake Victoria waters, although light penetration does vary from one locality to another. Clarity tended to be limited to several metres or less in the study area. We were fortunate to secure the services of Mr. Ted Levett, a professional SCUBA diver with years of experience who works for the Uganda Electricity Board on safety and maintenance problems at the Owen Falls Dam. On October 18th, Mr. Levett dived from the '*IBIS*' in waters of the Ingira-Bay Buvuma Channel area where dense traces were found. He saw no fish but observed a one-metre layer of flocculent plant material covering the bottom.** With or without lights, visibility was limited and it is possible that fish moved out of the diver's sight range. Mr. Levett however maintains that fish, especially small fish, are not elusive when approached under water; he is often surrounded by them when working on the upstream face of the dam. Nevertheless, on three occasions when he dived close to the bottom the traces in his vicinity disappeared or became much less dense. Were these fish or was the flocculent material disturbed, becoming less dense, and thus not discernable to the echosounder? These and other questions could be answered by further work with SCUBA. One approach might involve the diver remaining motionless on the bottom for an extended period to observe whether or not fish returned to his vicinity. Another approach would be to work with lights at night when *Haplochromis* are known to move off the bottom and determine how readily they are observed.

** This meterial has the appearance of phytoplankton remains. GEE and GILBERT (1968) mention a 2 to 3 metre semi-flocculent layer of soft mud over a harder substrate. The surface mud contained much plant debris and supported quite a large population of molluscs. Such muds were common at the 5 to 15 metre depth zone.

PREVIOUS INVESTIGATIONS

The trawling done by EAFFRO i vestigators in the mid-1960's has been referred to previously. They made considerable use of the echosounder and hoped to correlate traces with the trawl and gillnet catches. However, they were not able to do this. A description of their early work with the echosounder was given by GEE (1966). He found that discrete traces in daytime hours had become diffuse and scattered during night-time hours. He believed that the traces were fish because of their characteristic "comet" or "plume" shape. In some instances we observed this same pattern, whereas on other occasions night traces did not differ from day traces. Gee's figures also revealed concentrations of traces around underwater projections which we also observed. This too would indicate the traces were caused by fish.

Further studies however created considerable doubt regarding the "organisms" responsible for the echo traces. GEE and GILBERT (1967) concluded that there was no correlation bctwen the density of bottom traces and the catch of *Haplochromis* in bottom, midwater or surface trawls or in gillnets. They felt that the visible traces therefore emanated from either shoals of fish too small to be retained in one-inch mesh codend or "organisms" other than fish, of which plankton seemed the most likely. They also made the following pertinent observations: "If however, the echosounder would pick up either of the above items (very small fish or plankton) it should also pick up the *Haplochromis* caught in the trawl. Most of these however are bottom feeding forms, mollusc eaters, insectivores and bottom detritus feeders. They will presumably therefore be in elose contact with the bottom and if this is so they will be very difficult to distinguish (if it is possible at all) from the bottom echo itself. This hypothesis is borne out by observations made by the authors over a sand bottom using an aqualung. Large numbers of *Haplochromis* are often seen within 6″or 1 of the bottom or aetually resting on the bottom, but if the diver paused for any length of time in mid-water very few if any *Haplochromis* are even encountered."

GEE and GILBERT (op. cit.) discuss the possibility of other fish species being responsible for the traces. They note that catches of *Alestes sadleri* were high in shallow bays and very high over sandy bottoms in the sheltered areas. This correlated fairly well the density of the echo traces. This could hardly be expected to apply in the present study however since not a single *Alestes* has been captured in the study area. The authors also noted a correlation between the presence of *Tilapia esculenta* and a very fine diffuse trace present over the mud bottom up to about 5 metres from the bottom along with a patchy or somtimes heavy comet-shaped trace. They hypothesized that the comet trace was *T. esculenta,* whereas the diffuse trace was

Melosira — a silicaceous, filamentous diatom. *T. esculenta* is a phytoplankton filter feeder in which *Melosira* forms a significant quantity (about 20% by weight) of the stomach contents. "Other evidence that many of these traces may in fact be aggregations of plankton was noticed while diving off Ramafuta Island in an attempt to identify some traces seen on the echosounder. They were very similar to those described above but rather patchy. On two successive dives no fish were seen but water masses where the light intensity was drastically decreased were passed through at the same depth as the traces produced on the sounder. These facts are strong corroborating evidence for the above hypothesis and it is hoped that plankton analysis of water samples taken in and above these types of traces will give more direct evidence."

A few samples were taken on January 10th, 1967 with a Nanson-Peterson bottle and preserved in Lugoli's iodinc solution. In the laboratory, cell counts of *Melosira* were made. The unpublished results (J.M. Gee, EAFFRO) are shown in Table 2. They indicate that the very fine feather traces on the echosounder are probably concentrations of *Melosira*, but the stronger, less diffuse traces are probably not concentrations of this diatom. This is an encouraging lead, but the results can only be considered preliminary and further study would be profitable.

TABLE 2

Melosira Cell Counts in Relation to Echosounder Traces at Three Locations in L. Victoria

Fish trace over sand bottom on north of Ramafuta Bank		*Very fine feather trace* in middle of North Buvuma Channel		*Very fine feather trace* off North Buvuma Island near mouth of Pilkington Bay	
Depth (metres)	*Melosira* count	Depth (metres)	*Melosira* count	Depth (metres)	*Melosira*
Surface	2.0×10^6	Surface	1.5×10^6	4	2.7×10^6
5 (in trace)	0.5×10^6	5	2.0×10^6	7	1.0×10^6
		10	1.3×10^6	10.75 (in trace)	3.8×10^6
		18 (in trace)	3.7×10^6	13.75 (in trace)	4.2×10^6
		19.3 (in tracc)	4.5×10^6		

Unpublished EAFFRO data collected by J.M. Gee contained several additional pertinent observations relating to the echo trace question. He found that the traces appeared to move away from the diver and that they were reduced following ringnetting operations. We also observed the former, and it would seem that fish are responsible for this phenomenon. It remains possible however that disturbance and subsequent dilution of a phytoplankton swarm would achieve the same effect.

Gee also tonched upon the possibility that the traces are caused by small fish which pass through the one-inch mesh size codend. He examined the catch in a one-half inch (13 mm.) mesh size bag sewn over a one-inch codend and found that very few fish were missed. We also used a 13-mm. codend on a number of occasions plus the Lampara net which has a 10-mm bag and found nothing to indicate that very many smaller fish were being missed by the usual 20-mm codend. Like most cichlids, species of *Haplochromis* are mouth brooders and the fry could be expected to leave the mouth at a size large enough so that, if present in dense concentrations, strong evidence would appear in the 13-mm mesh size codend. This would not necessarily apply to *Engraulicypris* fry which are smaller and much more slender.

Finally, Gee mentions that *Haplochromis erythrocephalus* is a phytoplankton filter feeder like *Tilapia esculenta* and that its guts are usually full of *Melosira*. This is decidedly the dominant *Haplochromis* species in the waters north of Buvuma Island. It may be that during the study period (at least from September to December) these waters support large swarms of *Melosira* which are fed upon by *H. erythrocephalus* and that this combination accounts for the dense echo traces.

CONCLUSIONS

1. Daytime sampling with midwater trawls in the Ingira-Buvuma area yielded very small qnantities of *Haplochromis*, *Engraulicypris* and incidental catches of other species. This indicates that at least some segment of the echo traces are caused by these fishes.

2. The results of observations made with SCUBA and the absence of large fish catches from a variety of gear (beam and midwater trawls and the Lampara net) in areas with dense echo traces, infer that fish are not responsible for the bulk of these traces. The consistent lack of correlation between fish catch and echo trace density provides further evidence.

3. Although *Engraulicypris* fry cannot be discounted, it would appear, based on Gee's earlier work, that a segment, possibly a large segment, of the echo traces are caused by swarms of phytoplankton. The presence of *Haplochromis* and *Tilapia esculenta* feeding on these concentrations perhaps accounts for the heterogeneous appearance of the traces.

4. Evidence for the above statements however is not conclusive and the possibility remains that the bulk of the traces are caused by fish. The traces in some respects have the appearance of typical fish traces. Also, the sampling gear seems very inefficient. For example, small catches are made at night with midwater trawls despite the fact that they sample almost the entire water column and *Haplochromis* are known to move off the bottom at that time.

5. We have not yet identified the agents causing dense echosounder traces. More intensive studies are required to achieve this goal.

RECOMMENDATIONS

The direction and extent of further studies depends largely on available manpower and equipment. With several additions to the EAFFRO team of biologists slated to arrive within a few months, the survey of the pelagic zone can advance simultaneously on two fronts. The first proceeds on the assumption that the bulk of the echo traces are not caused by fish and that the existing midwater trawls, while not very efficient, adequately reflect the relative abundance and distribution of pelagic stocks. This programme utilizes existing personnel and the '*IBIS*', and consists of a renewal of the midwater trawl survey on a systematic area by area basis covering all of Lake Victoria. A series of cruises should be scheduled when the final bottom trawl cruises are completed. Midwater trawl survey methods described in previous reports should be followed except that specific sampling sites should be located systematically along a search grid established before each cruise. Some day trawling will be necessary, although night trawling is more productive. Fish tagging also will be an integral part of this study.

The second programme would pursue the work started on identification of the echo traces. Using Launch Number One, the following coordinated study phases can be expected to satisfactorily explain the origin of the traces:

1. With the echosounder on Launch No. 1, a careful description of the echo traces should be made in the study area at different times of the day and night.

2. To clarify the size relationships of the echo traces, objects of known size and perhaps fish themselves should be set out (using monofilament line and floats) and then cruised over with the launch to ascertain their appearance on the echosounder tape.

3. SCUBA should be employed in the manner described earlier in this report and surely will be valuable in other ways also; e.g. in helping assess size relationships of the echo traces and possibly in observing plankton and fish sampling gear in action.

4. The role of phytoplankton swarms in produeing echo traces should be examined. This would have to be done in close conjunction with SCUBA and echosounder operations.

5. Gillnets have not yet been tried as a sampling tool to help resolve the echo trace question. *Multifilament* gillnets have been used extensively in past studies at Lake Victoria, and they very effectively sample *Haplochromis* but apparently in overnight sets. Now that *monofilament* gillnets are available, their effectiveness in daytime sampling should be assessed. We are optimistic about this technique because of results attained in other lakes, and because the opacity of Lake Victoria waters should promote their usefulness. If initial results are encouraging, *vertical* panels of graded monofilament gillnets covering the entire water column can be set in some pattern in areas of differing echo trade density. The results of this effort in conjunction with the SCUBA and phytoplankton findings should resolve the echo trace question. In passing, it is worth observing that fleets of vertical monofilament gillnets could also facilitate a description of the diel movements of *Haplochromis* and the population dynamics of important species like *H. erythrocephalus* in the manner of Garrod's studies on *Tilapia esculenta*.

Some general comments and recommendations regarding midwater trawling and purse seining also seem worthwhile at this point. The midwater trawl survey thus far indicates low concentrations of fish in the pelagic zone during daylight hours. Dense traces seen in some areas during daylight may be fish and larger catches may accrue following further gear development. In any event, daytime catches will either remain at their present very low level or may increase somewhat but still remain extremely variable. The catches at night are already highly variable and largely reflect movement of fish from the bottom. Our present standing stock estimates are based on daytime bottom trawling and what we need from midwater trawling is an estimate of pelagic stocks for the daytime period also. Night midwater trawling cannot tell us this and only yields fish for tagging plus limited information on diel movements which is better gained using other techniques. Thus, the midwater trawl survey cannot be expected to greatly enhance the stock assessment picture of Lake Victoria fishes. It also has limitations for tagging since the larger species are not taken in proportion to their abundance; i.e. only occasional concentrations of *Tilapia* and *Clarias* are caught and generally very few individuals of the remaining species. *Bagrus docmac* in particular is seldom found in midwater trawls.

We would be better able to proceed with the tagging and stock assessment studies, if we could sample with a purse seine. Admittedly, there are some serious problems to be faced in successfully using this gear in areas where the substrate consists of soft mud. However, its ability to capture within a given area virtually all fish above a certain size has such great value in stock assessment studies that every effort should be made to obtain and test the purse seine in Lake Victoria. In previous stock assessment status reports, we recommended against using the large purse seine (190 fathoms long) originally slated for Lake Victoria. We were under the impression at that time that such a net would capture many tons of fish which would present difficult subsampling problems and the possible wastage of much fish life. However, in view of current standing stock estimates from bottom trawling and the low catches in the midwater trawls and Lampara net, it now seems that a net of this size, which encompass an area of only 0.7 hectare, would not be too large and anything smaller might be too small. Before expending funds on a purse seine which may or may not be sufficiently large or in other respects fit the particular conditions at Lake Victoria, it would be desirable to borrow one or more existing purse seines to conduct preliminary trials before deciding on the most effective type.

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FURTHER OBSERVATIONS ON THE ECOLOGY OF THE NILE PERCH *(Lates niloticus* LINNE,*)* IN LAKE VICTORIA AND LAKE KIOGA

J. OKEDI

INTRODUCTION

A pilot introduction of Nile Perch to Lake Kioga was undertaken in 1955 (GEE 1969) after lengthy arguments for and against such introduction particularly for Lake Victoria where the *Tilapia* form an important fishery. GEE (1969) has stated that the first appearance of *Lates niloticus* in Lake Victoria was noted in 1960 but thereafter there were several planned introductions. Further, GEE (1965, 1969) recorded preliminary observations of the biology of *L. niloticus* in the two lakes during the early 1960s. Ever since then, there has been continued lamentation that Nile Perch is exterminating the important *Tilapias* of both Lakes. Observations recorded here were therefore partly conducted to determine the magnitude of the problem as well as the validity of these complaints.

Fluctuations in catches and total production in a fishery are dependent on many factors e.g. seasonal migrations of fishable stocks, seasonal activity of fishermen and changes in their fishing grounds, recruitment success of young fishes as well as relative success of spawnings, ete. Predation on the other hand can cause depletion of commercial stocks if the predator impact is sufficiently heavy. In most natural populations, however, the relationship between the predator and prey is regularised and fluctuates without either predator or prey becoming exterminated. However, Nile Perch is a "new" predator in both Lakes Victoria and Kioga, having become extinct in Lake Victoria after the Miocene period.

The present investigation further represents a continuation of observations on the ecology of *L. niloticus* in Lakes Vietoria and Kioga. Undertaken during the late 1960's and early 1970's, it presents certain valuable comparisons to earlier observations by Dr. J.M. Gee during the early 1960's. The work of Dr. J.M. Gee during the early 1960's therefore serves as a useful baseline for comparative purposes. In Lake Victoria, relative availability and population changes particularly amongst the *Tilapia* are indicated by WHITING (1969) in regard to the diminishing catch per unit of effort of the *Tilapia*. Hence, any population changes amongst the *Tilapia* stoeks in Lake Vietoria eannot solely be attributed to predation by Nile Pereh. It is necessary therefore to eonsider population ehanges in relation to fishing effort and fishing gear as well. In Lake Kioga, however, information on population structure of the commercial stocks prior to the introduction of Nile Perch is almost lacking. In this respect, GREENWOOD's (1960) description of the fishes of this lake gives some useful guidelines as to species prevalance at that time.

HABITAT AND DISTRIBUTION

Table I shows the samples and sex ratios of Nile Perch caught from Lake Victoria and Lake Kioga. The sex ratios of *Lates* from Lake Kioga is biased in favour of males unlike the Lake Victoria specimens where the sex ratio did not show any significant differences. This may be due to sampling techniques. In Lake Kioga most of the fish were caught either in the gillnet or in the hooks whereas in Lake Victoria gillnets, hooks, trawls and seines were all employed for sampling with varying degrees of efficiency.

TABLE I — Number of Nile Perch examined in Lakes Victoria and Kioga

	Number examined	Number ♂	Number ♀	Number immature
Lake Victoria	1880	935	944	2
Lake Kioga	746	435	282	29
SEX RATIO	Lake Victoria	49.7%	50.3%	
	Lake Kioga	60.6%	39.3%	

More than 80% of the samples in Lake Victoria were obtained from the commercial gillnets. The research vessel 'IBIS' was used for trawling and a beach seine net was operated mainly at Namone which is asandy beach sloping from 0-10 metres deep.

Lake Kioga is shallow, less than 12 metres deep in most parts. In this lake immature specimens of *Lates* were caught in the fringing vegetation which was mostly in the shallow water lily zone assocaited with *Vossia*, *Ceratophyllum*, reeds and water lilies. The larger Nile Perch caught in the same habitat were found to have fed largely on the fry and juveniles of *Lates* itself. It is inferred that post larval *Lates* juveniles live and grow in the zone of fringing vegetation in Lake Kioga. This would seem to have obvious survival advantages from predation. However, the Nile Perch is now widespread in Lake Kioga and contributes significantly to the commercial fishery in this lake.

Trawling surveys in Lake Victoria have given a good indication of the distribution of *Lates* in this lake. Nile Pereh is limited to water less than 25 metres deep. Of a total of 262 specimens taken in trawls more than half (56%) were caught in the shallow 5-10 metres depth zone, 5% in 10-15 meters, 13% in water 15-20 meters deep and 24% in water 20-25 metres deep. Only 0.6% by number were caught in water 25-30 metres deep. Simultaneously all the specimens taken in gillnets were caught in water 5-20 metres deep. It seems therefore that *Lates* has as yet not colonised the deeper waters of Lake Victoria. GEE (1964) has shown that Nile Perch introduced into Lake Victoria were mainly from Lake Albert consisting of a parent stock of a shallow water form of *Lates niloticus*. This species is sensitive to low oxygen tensions and easily dies in water with high content of CO_2. Lake Victoria under-goes periods of deoxygenation in the bottom waters (TALLING 1957) and although deoxygenation is not complete, oxygen saturation may fall below the level tolerated by *Lates*. It is perhaps too early to judge whether Nile Perch will ever completely colonise the offshore waters of Lake Victoria.

GEE (1965) reported that the distribution and spread of Nile Perch in Lake Victoria followed the eastern shore up to Nyanza Gulf in Kenya and slightly south of Musoma in Tanzania. During trawling surveys with the research Vessel 'IBIS' *Lates* were commonly taken from the Uganda waters of Lake Victoria. The midwater trawl, although still on trial basis, tended to catch more Nile Perch than the bottom trawl. Good catches of Nile Perch were also made at the entrance to the Nyanza Gulf in the Kenya waters indicating regular occurrence of *Lates* in this area. Off Suguti Bay in the Tanzanian waters south of Musoma, one Nile Perch was caught by a bottom trawl on 22nd January, 1971 weighing 3.3 kg and 50.6 cms standard length. It has also been reported by the Tanzania Fisheries staff at Mwanza that several specimens identified as Nile Perch have been spotted in the Mwanza Fish Landing.

The first Nile Perch to be caught in the western shores of Lake Victoria was recorded south of Bukoba. This fish was taken in a bottom trawl on 28th May, 1969 in water 26–28 meters deep. It was a male, 35.0 cms standard length weighing 1.0 kg and its gonad was developing to sexual maturity. *Lates niloticus* have in fact spread westwards along the Uganda Tanzania border in Lake Victoria as evidenced by the occurrance of this specimen.

However, their spread eastward along the Uganda Kenya border has been more successful. GEE (op. cit.) suggests that the presence of more bays and well indented coastline in the eastern shoreline offers better protection and better chances of survival for the Nile Perch than the western coastline which is rather open.

Table 2A shows various sizes of male and female fish from both Lakes Victoria and Kioga. The male and female specimens from Lake Victoria were larger in terms of length than those from Lake Kioga. In both lakes the females attained larger sizes than the males. Further, the sizes of the smallest male and female specimens examined are shown to be less than 21.0 cms total length (standard length 17.0 cms)

Table 2A The sizes of the Nile Perch caught in Lakes Victoria and Kioga

		Total Length cms	Standard length cms	Body weight Kg.	Method
Lake Victoria	Largest ♂	122.5	109.8	33.0	Trawl
	Smallest ♂	21.0	17.0	0.1	Gillnet
	Largest ♀	164.0	118.0	41.3	Trawl
	Smallest ♀	18.5	15.0	0.125	Gillent
Lake Kioga	Largest ♂	102.5	86.5	12.8	Hooks
	Smallest ♂	14.2	12.0	0.03	1½ inch Gillnet
	Largest ♀	146.0	125.0	49.0	Hooks
	Smallest ♀	20.5	16.5	0.10	1½ inch Gillnet

Table 2B

The maximum weights of indvidual Nile Perch caught in Lakes Victoria and Kioga.

		Weight Kg.	Length Standard	Lengthth Total	Method
	♂	28.1	92.4	105.3	Trawl
Victoria	♀	63.6	102.5	146.5	Seine
	♂				
Lake		12.8	86.5	102.5	Hooks
Kioga	♀	49.0	125.0	146.0	Hooks

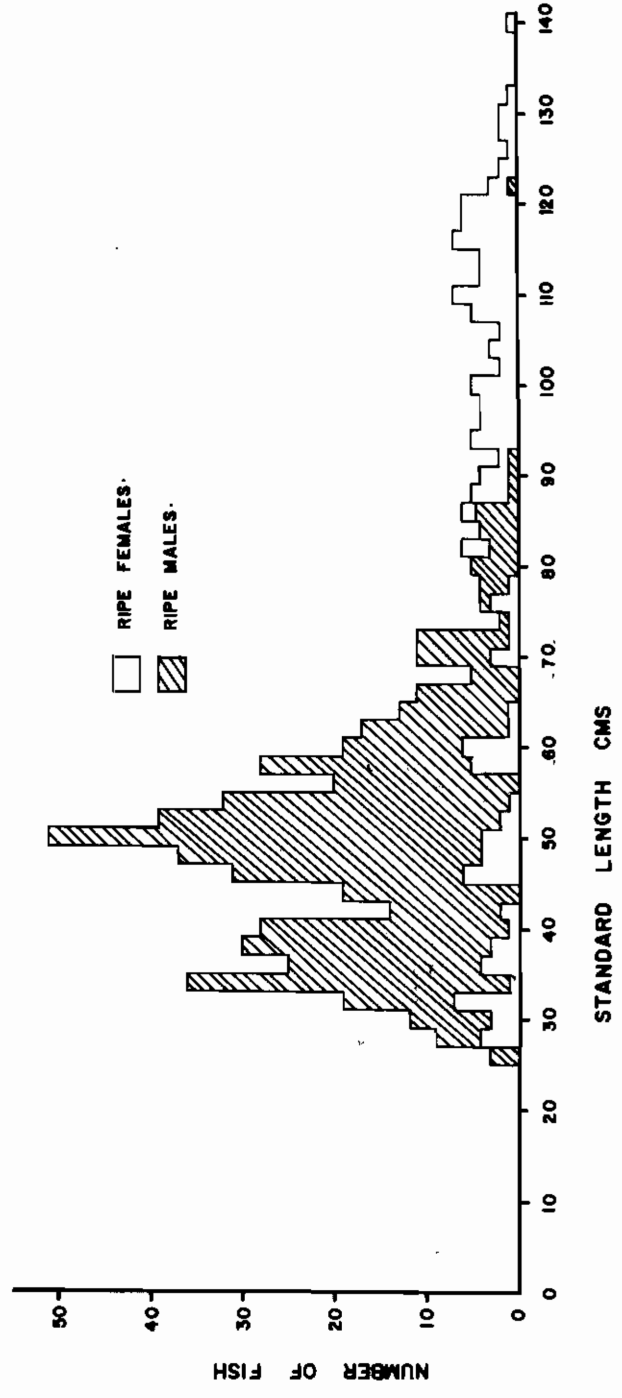
Below these sizes, it was not possible to recognise the sexes by eye.

In Table 2B, the largest individuals by weight from Lakes Victoria and Kioga are shown. The Lake Victoria specimens were generally larger than those from Lake Kioga. The largest individual was a female from Lake Victoria weighing 63.6 Kg and was caught in a seine net at Namone. The largest specimen measured by Dr. J.M. Gee from Lake Victoria in 1964 was only 5.9Kg in weight. In Lake Kioga the largest fish caught was a female 49.0 Kg. in weight and captured by hooks. It is interesting to note that the total lengths of both the Lake Victoria female (63.6 Kg) and the Lake Kioga female (49.0 Kg) was almost the same i.e. 146.5 cms and 146.0 cms respectively. It is noted, however, that ripe fish are often characterised by heavy accumulation of abdominal fat. Although it is probable that sexual maturity could account for weight differences of individuals of similar lengths, the difference between the Lake Victoria and Lake Kioga specimens (14.6 Kg) is much too high to be accounted for by fat accumulation alone. It is probable that the Lake Victoria specimens are able to grow to larger sizes due perhaps to better environmental conditions e.g. availability of food. It is shown below that in Lake Victoria, the *Haplochromis* form the major food but that in Lake Kioga, *Engraulicypris* and Odonata are the chief prey. The mean weight of food in the stomachs of 438 Nile Perch examined in Lake Victoria was 23.6 gms. In Lake Kioga, the mean weight of food of 502 Nile Perch stomachs was only 12.1 gms.

It is observed from Tables 2A and 2B that the largest individuals in terms of total length were not necessarily the heaviest. In most cases the females tended to be fatter with larger girth measurements and the males tended to be elongate and slimmer around the belly region.

SEXUAL MATURITY

Fig. 1 shows the numbers of male and female Nile Perch that were found to be sexually ripe at various standard lengths. Sexually ripe males tend to increase from standard lengths 25–27 cms to reach peak activity at 30–60 cms standard length. From there the numbers diminish gradually to minimal sexual activity at standard lengths 87–93 cms. It would seem therefore that the male Nile Perch in Lakes Victoria and Kioga attain sexual maturity at 25–27 cms standard lengths. The histogram for males represents the distribution of ripe male fish in the population. The females on the other hand tend to show no peaks in sexual potency, ripe fish occurring uniformly from 27–29 cms standard length to 131–133 cms standard length. The occurrence of sexually ripe females at the higher length range (+100 cms) reflects the phenomenon already observed that female Nile Perch grow larger than males. It is further indicated here that even at this relatively large size and old age, sexual activity persists. However, sexually ripe females were first observed at standard lengths 27–29 cms and this would indicate the size at which they attain sexual maturity. The smallest sexually ripe male was 25.4 cms standard length weighing 375 gms whereas the smallest sexually ripe female was 27.2 cms standard length, weighing 500 gms.


RIPE FEMALES.
RIPE MALES.
NUMBER OF FISH
STANDARD LENGTH CMS
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140

THE GONAD

In the female the ovary of young immature fish is small and whitish but becomes deep red on further development. However, when ripe the ovary is cream in colour and often weighing several kilogrames in a mature female. The testes in the male start development as a thin almost colourless thread which becomes white grey on maturing. In both sexes the gonad is bifid.

THE OVA

The ova of *Lates niloticus* are very small and circular, measuring approximately 0.6mm when fresh. They are full of numerous oily globules, the wall being some what transparent. On emersion in water, the ova immediately float to the surface. Their transparency and lack of pigmentation probably indicates that they would normally develop in environments rich in oxygen. However, being preserved, the ova seemed to shrink both in formaldehyde (5% concentration), in Smiths Formal Bichromate Solution and in alcohol (70%). Ova from 20 ripe females were preserved in both 5% Formaldehyde solution, 70% alcohol and Smiths Formal Bichromate and measured. Their mean diameter after preservation was 0.48 mm, the range recorded being 0.44 – 0.55 mm.

EGG COUNTS

After preservation in 5% Formaldehyde solution, ova from eight ripe ovaries (8 females) were counted manually with the aid of a binocular microscope. Portions of about 0.05 gms of the ovary were sliced and the ova counted. The total ova being obtained by ordinary multiplication. The mean number of ova per ovary was 7,311,040; the number was variable depending on several factors e.g. size of female, size and weight of ovary etc. The range of counts therefore gives a better distribution, in this case between 1,104,700 and 11,790,000. Average number of ova per gram was 6,828.

It would appear therefore that Nile Perch is one of the most fecund species in Lakes Victoria and Kioga. LOWE (McConnell) (1955) has shown that the *Tilapias* (Cichlidae) produce only a couple of hundred eggs at a time. The Mormyridae too produce a small number of large yolky ova often in hundreds but the larger species attain higher numbers (OKEDI 1970). A Cyprinid fish studied by CADWALLADR (1965) had even smaller ova, mean diameter 0.13 mm but maximum numbers of ova were only 162,525. However, because of its larger size, Nile Perch has greater capacity to produce large numbers of eggs. It is not yet certain what proportion of these eggs successfully hatch and develop. It is known that higher fecundity has survival advantages in that although a large proportion of ova may not be successfully fertilized and developed, a substantial number will stand good chances of fertilization and possibly grow to maturity. The breeding of Nile Perch has yet to be unravelled and its early life history remains largely unknown.

THE FOOD OF **LATES NILOTICUS** IN LAKES VICTORIA AND KIOGA

Table 3 shows a comparison of some aspects of the feeding of Nile Perch in the two lakes where it was introduced. In Lake Kioga Nile Perch is more able to obtain food than in Lake Victoria. A greater percentage of stomachs examined from Lake Victoria contained no food. This may itself reflect on the availability of prey in the two habitats. It is evident from this Table too that Nile Perch is dependent, for food, on mainly one species in Lake Victoria unlike Lake Kioga where there is more diversity in the species captured. Hence, well over half of the Nile Perch examined in Lake Kioga had more than one prey species whereas only about 8 percent in Lake Victoria had eaten more than one prey species at any one time.

Table 3: A comparison of the feeding of *Lates niloticus* in Lakes Victoria and Kioga

	No. examined	No. containing food	No. without food	No. with one prey species	No. with more than one prey species
Lake Victoria	754	438 (58 %)	316 (41 %)	407 (92 %)	31 (8 %)
Lake Kioga	631	502 (79 %)	129 (20 %)	188 (37 %)	314 (62 %)

Table 4 shows the percentage occurrence of various prey items in the stomachs of Nile Perch, both from Lakes Victoria and Kioga. In Lake Victoria only *Haplochromis* appeared regularly in the stomachs of Nile Perch (46% occurrence) all other identifiable prey species appearing at less than 2% level. In Lake Kioga, however, a small Cyprinid fish *(Engraulicypris)* and a Libellulid (Odonata) were the most commonly occurring items in the stomachs of *Lates*. The *Engraulicypris* appeared in just over half the stomachs examined and the Odonata in just less than half of the stomachs looked at. In both lakes, the *Tilapia* were less significant and only in Lake Kioga did they appear in just over 6% of the stomachs. Further, only in Lake Kioga were *Caridina* (Crustacea), *Povilla* larvae (Insecta) and *Lates* juveniles ingested by Nile Perch. The *Haplochromis* which are paramount in Lake Victoria were of very minor significancc in the stomachs of *Lates* from Lake Kioga.

TABLE 4—PERCENTAGE OCCURRENCE OF VARIOUS PREY SPECIES IN STOMACHS OF *Lates niloticus*

	Lake Victoria	*Lake Kioga*
Number of Stomachs examined	754	631
Tilapia	1.0	6.8
Haplochromis	46.0	3.1
Lates	0	4.1
Clarias	1.2	0
Mormyridae	0.4	0
Engraulicypris	0.4	53.8
Odonata	0.5	45.4
Caridina	0	8.0
Povilla larvae	0	1.7
Others	11.4	9.1

The contribution of various prey items as food of Nile Perch is portrayed in Table 5. From a total of 754 fish examined in Lake Victoria, 10,338.8 gms of food was collected representing various assemblage of prey species. Similarly in Lake Kioga, 631 *Lates* were examined and the consequent stomach contents weighed 6,097.4 gms.

As expected and arising from some understanding of percentage occurrence, the *Haplochromis* were by far the chief food of Nile Perch in Lake Victoria constituting more than 80% by weight of prey eaten. The *Tilapia* were largely inferior, making up only 8% of the weight of food eaten.

In Lake Kioga, although the *Tilapia* made 6.8 percentage occurrence, they contributed 58% by weight of the food eaten and are therefore extremely important as nutrient suppliers in the feeding ecology of Lates in this Lake. The *Engraulicypris* and Odonata nymphs which each occurred in about half the stomachs of *Lates* examined, only contributed less than 30% (the two combined) by weight of *Lates* prey.

The Odonata were even less significant forming only 5.6% in weight of the food ingested by Nile Perch in Lake Kioga. Hence, the *Lates* juveniles were more important as the food of Nile Perch than *Haplochromis* and Odonata, the only other two items that were worth noting in Lake Kioga.

TABLE 5—THE WEIGHTS IN PERCENTAGES OF VARIOUS FOOD ITEMS INGESTED BY *Lates niloticus*

	Lake Victoria	*Lake Kioga*
Total Weight of prey in the stomachs of *Lates* examined (gms)	10,338.8	6,097.4
Tilapia	8.0	58.0
Haplochromis	84.0	1.0
Lates	0	8.0
Clarias	2.8	0
Mormyridae	0.4	0
Engraulicypris	0.4	23.4
Odonata	0	5.6
Caridina	0	0
Povilla larvae	0	0
Others	3.8	2.5

Consequently, in Lake Kioga, cannibalism provided an opportunity of studying the feeding requirements of juvenile Nile Perch which had proved difficult to sample in this environment. Twenty one such Nile Perch fry (standard length range 1.3–6.7 cms) were found intact after having been recently ingested by variously sized adult Nile Perch. The stomach contents from these Nile Perch fry were well preserved and capable of examination.

Of the twenty one stomachs of Nile Perch fry examined, twelve or 57.1% contained food and these had only one prey species at a time. The major diet of these small fry were mainly *Caridina* which occurred in 14.3% of the stomachs, unidentified insect larvae (14.3%) and *Povilla*, 4.7%. Other unidentified Crustacea formed 23.8% level of occurrence. The only fish ingested were juveniles of *Engraulicypris* which occurred in just under

10% of the stomachs. Hence insects and Crustacea appear to be important food of the young stages of *Lates* in Lake Kioga.

GEE (1969) found that generally prey size in *Lates niloticus* increases with the size of the predator. He found that the proportion of predator body length to prey body length was often in the region of 25%, rarely exceeding 30%, and his largest figure was 33%. In my specimens, a female Nile Perch from Lake Kioga (total length 146.0 cms standard length 125.0 cms and body weight 49.0Kg) had ingested one large *Tilapia nilotica* which had total length as 52.0 cms, standard length 42.0 cms and body weight as 2.8 Kg; the proportions between prey and predator size being respectively 35.6% for total length, 33.6% for standard length and 5.7% for body weight.

Fishermen in Lake Kioga commonly report the appearance of a Nile Perch floating dead on the water. In many eases, a large *Tilapia nilotica* is often found stuck inside the buccal cavity of *Lates niloticus*. Death invariably arises from asphyxiation through attempting to swallow too large a *Tilapia*. *Tilapia nilotica* are known to grow fast and attain large size in Lake Kioga where specimens of 4–7 Kg (or 10–15 lbs) are commonly caught. The upper range of the size of prey is limited and depends on the size of predator itself.

GEE (1969) counted 35 Cichlids in a stomach of 55 cms standard length Nile Perch from Lake Kioga. In my samples however, one *Lates niloticus* from Lake Victoria (standard length 110.0 cms, body weight 30.0 Kg) had a total of 57 *Haplochromis* individuals in its stomach. The *Haplochromis* prey weighed a total of 342.4 gms (1.1% of predator body weight) and ranged in standard length between 4.4–8.0 cms. In Lake Kioga, on the other hand, the highest number of individuals of the same species in the stomach of *Lates* were formed by 18 *Engraulicypris*.

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FISHERY ECONOMICS STUDIES

C.K. NSHERENGUZI

The biggest problem and task for the economics section of EAFFRO/UNDP was the establishment and development of improved methods of collecting statistical data from all important fisheries of East Africa. Without reliable data and continuous inflow of information regarding periodical catches, canoe catches, fishing intensity and productivity, types of gear and number of fishermen together with other relevant information no effective development studies and planning for the fishing industry can be achieved.

Priority was given to Lake Victoria the biggest lake in East Africa which is the only lake shared amongst the member countries. Beach surveys were made in Kenya, Tanzania and later in Uganda. The work of collecting statistical data regarding annual catches, beach landing statistics, gear, canoe catches and fishing intensity was actually started along the Kenyan shores of lake Victoria. The "Weighing System" was introduced on many of Kenyan fish landing stations with the aim of obtaining more reliable information and improving the standard of data collection. As a result, therefore, this new system proved to be practicable and has now been adopted by the Kenya Fisheries Department.

Similarly the same system was introduced on several fish landing stations along Tanzania shores of Lake Victoria. Moreover, this system operates side by side with the traditional "Sampling System" so that a comparison of efficiency between the two methods could be made. The first station was set up at Mwanza and later on five more stations were started at the following beaches : Kalemera, Musoma, Nansio (on Ukerewe

Island) Nyakaliro and Bukoba. Several trips were made to these stations to supervise and render the necessary assistance to the fisheries staff. Experience has shown that the weighing system supersedes the old sampling system.

With the help of the Fisheries Assistants provided by the Uganda Fisheries Department a recording station was set up at Majanji on the north-western part of Lake Victoria. Majanji proved unsuitable for our cost studies, because there were very few fishermen landing fresh fish daily. In fact the landing is more famous for processed fish from offshore islands and not for fresh fish as assumed. Katebo fish landing on the western shore of the lake was chosen for trial. The Fisheries Assistant from Majanji was transferred to Katebo in April and was to stay there for a couple of months. It is, however, worth noting that this station is providing valuable data and information regarding the fishing intensity, and productivity, catch per unit effort, cost and earning studies, consumption and distribution of fresh fish in such rural areas.

COAST AND EARNING STUDIES

LAKE ALBERT

In response to Uganda Fisheries Department's request to UNDP/EAFFRO, studies on various types of fishing craft and gear on Lake Albert were conducted in order to compare their efficiency and profitability. Beach surveys were carried out and four recording stations were set up at Ntoroko, Butiaba, Bulisa and Wanseko to provide the data and information for cost and benefit studies of Kabalega, Congo Barque and Dug-Out canoes. Because of some management problems the migrating nature of the fishermen from the selected landings have caused several gaps in the flow of continuous data.

LAKE VICTORIA

As little is known of the costs and earnings of fishermen on Lake Victoria, studies of several selected fishermen operating from Lingira Island, which is about 12 miles from Jinja, have been commenced. A lot of data was collected and from Lingira Island attempts were made to collect first-hand value of the eatches at Masese.

MARKETING

Several market surveys and test-marketing experiments with fresh fish were carried out in different parts of East Africa, including Shinyanga, Maswa, Musoma and West Lake Regions in Tanzania; Kampala and in and around Jinja in Uganda and Nyanza Province of Kenya.

The experiments made are not adequate, but the information already at hand gives an idea regarding the marketability and distribution of fresh fish in both urban and rural areas.

It is noted that only few towns like Mwanza and Shinyanga in Tanzania are able to absorb reasonable quantities of fresh fish daily. In rural areas, poor road communications, lack of organised markets and low incomes among the peasant farmers are the main problems hampering a fair distribution and consumption of fresh fish. Information collected from Kampala and Jinja markets indicate that there is a feasible market for an increased supply of fresh fish in these towns and the prices offered for fresh fish in these urban areas are perhaps reasonable enough to support the introduction of trawlers. Some marketing experiments with sun-dried *Haplochromis* were also carried out in Jinja, Tororo and Mbale in Uganda and in Nyanza Province in Kenya but with very limited success. Complaints have been raised that *Haplochromis* is too bony and tasteless.

OBSERVATION ON FISH MARKETING EXPERIMENTS IN TANZANIA

C.K. NSHERENGUZI

In order to study the impact and complications of the envisaged increase of fish production due to the possible introduction of trawler fishing on Lake Victoria, extensive market surveys and test marketing experiments were carried out between 1969 and 1970 in Shinyanga, Mara (Musoma) and West Lake Regions. Market surveys were first carried out with the object of selecting suitable inland markets for test marketing experiments. Test marketing experiments were then conducted at Shinyanga, Maswa and Tarime, and trial marketing experiments were carried out in Musoma and Bukoba districts.

SHINYANGA

The test marketing experiments done at Shinyanga town market indicated that there is a feasible market for an increased supply of fresh fish. Secondly, the retail prices offered for the fish are reasonably high to make a fishmonger operating with a small van attain some profit margin. The market's daily absorpitive capacity could fall within the range between 1/4 to 1/2 ton of fresh fish.

The problem is that the fish consumers in this area are used mainly to the *Tilapia*. This means that one has to make sure that a bigger percentage of the supplies is made up of this popular species. Fresh *Clarias* and *Bagrus* are still not so popular in the region because they are new species to the consumers. *Haplochromis* of big size could find some market, but not the smaller ones. Fresh *Protopterus* has no market in the area.

Mwadui Township (13 miles from Shinyanga) with not less than 3,000 wage earners employed by the Williamson Diamond Ltd. and Almas Ltd. constitutes another feasible market for Lake Victoria fish. Due to the lack of regular fish suppliers, the majority of the African workers get no supply of fresh fish in this township. The Super Market in the town stocks only a few kilogrames of *Tilapia* fillets for the European community and some Africans of higher incomes. The whole township harbours a total of about 7000 people. It would be worthwhile to carry out further market research in this township.

MASWA

A few marketing experiments carried out at Maswa township indicated that the market can absorb between 200 – 300 kg of fresh fish daily.

MARA (MUSOMA) REGION

Extensive market surveys were done in this region. Tarime was the only inland market suitable for experiments.

The experiments carried out a Tarime Minor settlement showed that the market can handle between 200 – 250 kg of fresh fish daily but the prices offered for the fish are too low.

WEST LAKE REGION

Some trial marketing experiments were carried out in January 1970 in some rural markets within 35 to 55 miles away from Bukoba town. The markets attended include Kamachumu, Nshamba, Rubya and some other markets in different parts of Bukoba district. It was observed that the lack of organised markets and low purchasing power prevailing in the area are the major problems hindering the distribution of fresh fish in rural areas.

GENERAL OBSERVATIONS, REMARKS AND SUGGESTIONS

It must be mentioned that the marketing experiments carried out in the regions mentioned are inadequate for final conclusions. But, these few exploratory experiments have opened the way for future economic surveys and market studies. However, an idea on the acceptability and marketability of different species of fresh fish in different parts of Tanzania has been gained.

Because of poor transport communications, low purchasing power amongst the population, scattered populations and the lack of organized markets, it is at present not possible to plan for the introduction of modern and sophisticated methods of distributing fresh fish in the inland rural areas. Hence, the present method of allowing small fresh fish traders transport their supplies by buses and bicycles should perhaps continue to operate for some time.

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212. MIDGLEY, S.H. A study of Nile Perch in Africa. The Winston Churchill Memorial Trust (Australia). *Fellowship Report*, No.3, 1968.

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215. WELCOMME, R.L. Studies on the effects of abnormally high water levels on the ecology of fish in certain shallow regions of Lake Victoria. *J. Zool. Lond.* **160** : 405–436.

216. GREENWOOD, P.H. A revision of the cyprinid species *Barbus (Enteromius) radiatus* Peters, 1853, with a note on the synonymy of the subgenera *Beirabarbus* and *Enteromius*. *Rev. Zool. Bot. Afr.* **82** : 1–13.

217. OKEDI, J. A study of the Fecundity of some Mormyrid fishes from Lake Victoria. *E.Afr. Agr. & For. J.* **35** : 436–442.

218. TJONNELAND, A. A possible effect of obligatory parthenogenesis on the flight activity of some Tropical Larva-aquatic insects. *Acta Universitatus Bergensis.* Mat. – Naturv. Serie, No.3, 1970.

219. HYDER, M. Gonadal and reproductive patterns in *Tilapia leucosticta* (Teleostei : Cichlidae) in an equatorial lake, Lake Naivasha (Kenya). *J. Zool. Lond.* **162** : 179–195.

EAFFRO OCCASIONAL PAPERS

No. 1. ELDER, H.Y. Report on investigation into the *Tilapia* population of Lake Naivasha, Kenya. 1966.

No. 2. EAFFRO. The History and Research results of the East African Freshwater Fisheries Research Organisation from 1946–1966. (1967).

No. 3. EAFFRO. East African Freshwater Fisheries Research Organization. Annual Report 1948. (Reprinted).

No. 4. EAFFRO. Complete list of Published Works. 1967.

No. 5. GEE, J.M. and GILBERT, M.P. The establishment of commercial fishery for *Haplochromis* in the Uganda waters of Lake Victoria, Part I, 1967.

No. 6. MANN, M.J. The Fisheries of Lake Rukwa, Tanzania, 1967.

No. 8. GEE, J.M. and GILLBERT, M.P. The establishment of commercial *Haplochromis* fishery in the Uganda waters of Lake Victoria – Part II. 1968.

No. 9. MATHES, H. The Fishes and Fisheries of the Ruaha River Basin, Tanzania. 1968.

No. 10. MANN, M.J. A brief report on a survey of the fish and fishery of the Tana River with special reference to the probable effects of the proposed barrages, 1969.

No. 11. GEE, J.M. The establishment of a commercial fishery for *Haplochromis* in the Uganda waters of Lake Victoria – Part III, 1969.

No. 12. MANN, M.J. Catalogue of EAFFRO scientific archives, 1969.

No. 13. CHILVERS, R.M. Bottom trawl codend mesh selectivity for *Bagrus docmac* (Forskahl) from Lake Victoria, with some remarks, on the proposed Trawl Fishery, 1971.

MEETINGS

EAAFRO was host to an important FAO meeting on Stock Assessment. This meeting brought together FAO Experts in Stock assessment from Headquarters in Rome as well as from Six UNDP/FAO Projects operated in different countries in Africa. It was indeed a work of recognition for EAFFRO's participation in Hydrobiology and Fishery investigations for such a high powered meeting to be held at Jinja.

Several other important meetings in which EAFFRO participated are given as follows:

DATE	
19.1.1970	Heads of Departments Meeting: Arusha Director attended.
3.3.1970	Executive Committee of the E.Africa Natural Resources Research Council : Kampala. Director attended.
20.3.1970	Research and Social Council Meeting : Arusha. Director attended.

20.4.1970	Research Council and Technical Aid Meeting : Arusha. Director attended.
5.5.1970	Freshwater Productivity in the aquatic environment Seminar : Poland. Mr. G.E.B. Kitaka attended for one month.
11.5.1970 To 16.5.1970	FAO Stock Assessment Seminar : Jinja. All EAFFRO Biologists and Economists attended along with FAO Experts from 5 Projects on the African Continent.
3.6.1970	Computerisation Committee : Nairobi. Director attended.
8.6.1970	Meeting with Chief Fisheries Officer Uganda – Entebbe. Director attended.
10.6.1970	Meeting with Chief Fisheries Officer Tanzania – Dar es Salaam. Director attended.
18.6.1970	Meeting with Mr. H. Allsopp FAO Regional Fishery Officer : Entebbe. Director and Mr. G. Kitaka attended.
9.7.1970	Research & Social Council Meeting Arusha. Director attended.
14.7.1970	Fisheries Technical Committee Meeting for East and Central Africa : Entebbe. Director, Mr. G. Kitaka, Project Manager and Mr. P. Whiting attended.
2.8.1970	Meeting on Lake Victoria Fisheries Research Project : Arusha. Director and Project Manager attended.
21.9.1970	Meeting of Heads of Departments in the E.A. Community : Arusha. Director attended.
12.10.1970	Finance Management Seminar for Heads of Departments in the E.A. Community : Arusha. Director attenced.
23.10.1970	Finance Management Seminar : Arusha. Mr. G. Kitaka and Mr. W. Asinuli attended.

VISITORS

The work being carried out in EAFFRO continued to attract significant attention as reflected by the large number of visitors. It is particularly encouraging to report that there was continued interest in EAFFRO from Officials of the Partner States of Kenya, Uganda and Tanzania. The Vice President of the Republic of Uganda, HON. John K. Babiha, M.P. and Minister of Animal Industry, Game and Fisheries visited EAFFRO. Two Ministers of the E.A. Community, the HON. Robert J. Ouko, M.L.A. (Minister for Common Market and Economic Affairs) and the HON. Shafiq Arain M.L.A. (Minister for Communications, Research and Social Services) visited EAFFRO for a whole day and in fact went trawling in

Lake Victoria on the Research Vessel 'IBIS'. The Honourable Ministers were pleasantly surprised by catches of more than one metric ton of fish in less than 30 minutes.

The Deputy Minister of Animal Industry, Game and Fisheries in the Republic of Uganda, HON. K.K. Karegyesa and the Deputy Minister of Communications Research and Social Services in the E.A. Community, HON. Gerald N. Kalya paid visits to EAFFRO at different times. The Permanent Secretary, Ministry of Natural Resources in the Republic of Kenya, Mr. J.M. Ojal and the Principal Secretary in charge of Research and Training in the Ministry of Agriculture Food and Co-operatives in the Republic of Tanzania, Mr. G. A. Semiti called on EAFFRO and were briefed about research programmes, achievements and administrative set up.

Similarly the Chief Fisheries Officers from the Partner States continued to render useful support to EAFFRO and their unfailing assistance was shown by their regular visits to the Research Organisation.

EAFFRO and the United Nations Personnel continued to collaborate and tremendous interest was expressed by the UN as seen by the large number of Officials both from the UNDP, FAO, UNESCO and WHO who visited EAFFRO. Both the UNDP Resident Representative Mr. Bon su Atafua and the FAO Senior Agricultural Advisor to Uganda, Mr. Roy Stout, were frequent visitors to the Research Organisation.

The list below therefore gives the names of some of the Officials who visited EAFFRO.

JANUARY

Mr. Bon su Atafua	*UNDP Resident Representative, Kampala.*
Mr. Roy Stout.	*UNDP Resident Representative, Kampala.*
Mr. Neville Morgan	*Nature Conservancy, Edinburgh*
Prof. and Mrs. L.C. Beadle	*University of Newcastle.*

FEBRUARY

Mr. N. Odero	*Chief Fisheries Officer, Kenya.*
Mr. E. Anyumba	*Ministry of Tourism and Wildlife, Kenya.*
Mr. S.N. Semakula	*Chief Fisheries Officer, Uganda.*
Mr. Stuart Goodings	*C.U.S.O. Kampala.*
Mr. Eugenio Manalo	*Hydromet Survey, Entebbe.*
Dr. P.H. Greenwood	*British Museum, London.*

MARCH

Mr. J.M. Ojal	*Permanent Secretary, Ministry of Natural Resources, Kenya.*
Mr. G.A. Semiti	*Ministry of Agriculture Food and Co-operative, Tanzania.*
Mr. B. Gilliver	*East African Agriculture and Forestry Research Organisation, Nairobi.*
Miss J. Kigundu and Catering class	*Uganda College of Commerce, Kampala.*
Mr. F. Byabato	*The Treasury, E.A. Community, Arusha.*
Mr. James Greenc	*United States Agency for International Development, Nairobi.*
Mr. A. Antroinen	*United States Agency for International Development, Nairobi.*
Mr. James W. Howe	*United States Agency for International Development, Nairobi.*
Mr. G. Rutabajunka and Class	*Uganda College of Commerce, Kampala.*
Mr. John Hansen	*Mulbox, Jinja.*
HON. Gerald N. Kalya	*Deputy Minister, Communications and Research, E.A. Community.*
Dr. Hubert Matthes	*Kunduchi Fisheries Institute, Dar es Salaam.*

APRIL

Mr. James W. Strongm	*Steeg. Production Inc. New York.*
Mr. G.N. Barker & Students	*Uganda College of Commerce, Kampala.*
Mr. L.F. DeCosta	*E.A.V.R.I. Entebbe.*

MAY

Dr. Salah El Zarka	*Kainji Lake Project, Nigeria.*
Mr. F.O. Otobo	*Kainji Lake Project, Nigeria.*
Dr. A. Lelek	*Kainji Lake Project, Nigeria.*
Mr. A.P. Sinyth	*Canadian High Commission, Nairobi.*
Dr. John Gulland	*FAO, Rome.*
Dr. William Bcckman	*FAO, Rome.*
Mr. Len Joeris	*Lake Kariba Project, Zambia.*
Dr. Ian Dunn	*IBP, Lake George, Uganda.*
Mr. K. Meecham	*FAO, Malawi.*
Mr. Don W. Kelley	*FAO, Rome.*
Dr. T.Petr.	*Makerere University – Kampala.*
Mr. Willis A. Evans	*Volta Lake Project, Ghana.*
Mr. C.J. Vanderpuye	*Volta Lake Project, Ghana.*

Mr. A.J. Mathotho	*Fisheries Department, Malawi.*
Dr. A.F.A. Latif	*Lake Nasser Development Centre, U.A.R.*
Mr. G.V. Everett	*Kafue Fishery, Zambia.*
Mr. Adhu Awiti	*Common Market Secretariat, Arusha.*
Mr. Edward Dommen	*Commonwealth Secretariat, London.*
Mr. Lasse Aasluum	*NORAD, Kampala.*

JUNE

Mr. Roy E. Stout	*UNDP/FAO, Kampala.*
Mr. Herbert Allsopp	*FAO Regional Fishery Office, Ghana, Accra.*
Dr. H. Matthes	*Kunduchi Fisheries Institute, Dar es Salaam.*
HON. K.K. Karegyesa	*Deputy Minister, Ministry of Animal Industry Game and Fisheries, Kampala.*
Mr. E.G.M. Tinka	*Assistant District, Commissioner, Busoga.*
Mr. C.K. Kivanyuma	*Secretary General, Busoga.*
Mr. A.W.K. Balunywa	*Administrative Secretary, Busoga.*

JULY

Mr. S.J. Moledinen	*Ministry of Works, Jinja.*
Mr. F. Lund	*FAO/SE Nairobi.*
Mr. J.M.K. Musokwa	*E.A. Community, Arusha.*
Prof. M.W. Schein	*West Virgina University, U.S.A.*
Mr. G.E. Edward	*E.A. Community, Nairobi.*

AUGUST

HON. Tom W.W. Wafula, M.L.A.	*Kitale, Kenya., Member, E.A. Legislative Assembly.*
AL-HAJ I.A. Kateba	*Research Secretariat, E.A. Community, Arusha.*
HON. John K. Babiiha	*Minister of Animal Industry Game and Fisheries, Kampala.*
Dr. G.W. Coulter	*FAO Bujumbura.*

SEPTEMBER

Mr. C.A. Eruways	*UNDP, Kampala.*

OCTOBER

Prof. L.C. Beadle	*University of New Castle.*
Mr. A.W. Nangwale	*Works Division, E.A. Community, Arusha.*
Mr. Farid Hnsuy	*UNDP Kampala.*
Mr. E.R. Carr	*I.D.C. – Kampala.*

NOVEMBER

Dr. A.J. Hopson	*Lake Rudolf Research Project.*
Dr. Anders Thorslund	*FAO, Rome.*
HON. C.H. Thornicroft	*Deputy Minister, Zambia.*
Mr. H.M. Nzunga	*Ndola, Zambia.*
Mr. C. Mulenga	*Lusaka, Zambia.*
Mr. B. Zulu	*Lusaka, Zambia.*
Mr. D. Chilens	*Choma, Zambia.*
Mr. M.K. Tembo	*Dar es Salaam.*
Mr. E.R.B. Member	*Lusaka, Zambia.*
Mr. W.H. Mwelwa	*Lusaka, Zambia.*
Mr. G.S. Kambole	*Lusaka Zambia.*
Mr. H. Kabanga	*Lusaka, Zambia*
Mr. M.L. Mpanga	*Lusaka, Zambia.*
Mr. Mwamba Mundubile	*Nairobi.*
Mr. J.M. Duma	*Lusaka, Zambia*
Mr. A.S. Lubinda	*Kabwe, Zambia.*
Mr. T. Nangombe	*E.A. Community, Arusha.*
Mr. R.H. Saidi	*E.A. Community, Arusha.*
Mr. D.G. Hamilton	*C.U.S.O. Kampala.*

DECEMBER

Mr. Roy Fischer	*C.U.S.O. Kampala.*
Mr. A. Kramer	*Fisheries Department – Mwanza.*
Mr. J. Obdam	*Fisheries Department - Mwanza.*
Mr. John Hope III	*U.S. Peace Corps, Kampala.*
Mr. A. Herman	*U.S. Peace Corps, Kampala.*
Mr. Elin Ramekey Wilson	*Norwegian A.I.D. Kampala.*
Mr. John L. Dibbo	*UNDP/FAO, Barbados.*
Mrs. Wendn B. Eik	*Oslo, Norway.*
Mr. Bent Johnanisen	*N.A.I.D., Norway.*
Dr. S. Sbaburvich	*Makerere University, Kampala.*
Dr. Ola M. Heich	*Makerere University, Kampala.*
Mr. J.A. Breian	*E.A. Literature Bureau, Nairobi.*
Mr. M.O. Abolarin	*Kainji Lake Project, Nigeria.*
Mr. Al-Haj I.A. Kateta	*E.A. Community, Arusha.*
HON. Robert J. Ouko, M.L.A.	*Minister for Common Market and Economic Affairs, E.A. Community, Arusha.*
HON. Shafiq Arain M.L.A.	*Minister for Communications, Research and Social Services, E.A. Community, Arusha.*